NATURAL HISTORY THEMES

ASESSIPPI PROVINCIAL PARK

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For Internal Purposes Only

FOREWORD

This Natural History Theme Study is one in a series that identifies the cultural history themes, management and visitor-oriented topics, and contemporary problems of Manitoba's Provincial Parks.

Its primary purpose is to be an aid to field staff in their preparation of material for dissemination to park visitors. Thus, the goals and objectives set for Asessippi Provincial Park could be met.

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INTRODUCTION

Manitoba has been divided into twelve natural regions identified in Park Systems Planning in Manitoba: The Natural Regions Component.[1] The limits of these regions constitute a combination of physiographic and natural vegetation boundaries. The physiography and vegetation of each region referred to are briefly summarized, followed by a listing of the parks in each region. Following this brief outline of the region is a list, to be used as a guideline, of the broad natural history themes that are characteristic of each park. This paper provides a format for identification, collation and classification of natural history themes for use in interpretative planning and programming.

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[1] Manitoba, Department of Tourism, Recreation and Cultural Affairs, Parks Branch. Park Systems Planning in Manitoba: The Natural Regions Component, by Rick Wilson. (Winnipeg: Queen's Printer, 1977).

REGIONAL IDENTIFICATION AND SUMMARY:

NATURAL HISTORY THEMES

The park's existing features which best represent the region and the individual park and/or are of Provincial or national significance will be selected and described in the appropriate geographical location. In this manner important themes will be evident for each park, and classification of their value for interpretation will be made possible. The features which give rise to natural history themes will be classified as to importance by using suitability objectives for interpretation. These features, selected as main themes or sub-themes, will be included in the format of this report.

I LAND FORMS AND PROCESSES

A. Geology

1. BEDROCK SIGNIFICANCE

Outcrop features are used to develop themes. Physical geology is referred to, i.e. chronological sequence, mineralization, deposition, sediments, metamorphics, igneous rocks, volcanic rocks and associated processes.

2. PALAEONTOLOGY

Chronology of life, specific species of importance, evolution.

B. Geomorphology

1. GLACIATION

The chronological history of glaciation, ice contact features, ice features, ice erosional processes, resultant visual effects,

depositional processes and features (which may also fall under the heading Fluvial/Lacustrine depending on theme relation and importance.

2. AEOLIAN

Erosional processes and features, depositional processes and features, dune formation and types.

3. KARST TOPOGRAPHY AND ASSOCIATION PROCESSES

Sinks, travertine deposits, etc.

4. FLUVIAL/LACUSTRINE

Fluvial erosional and depositional processes and features, fluvial profiles and physical character, lacustrine profiles and character.

5. VOLCANIC FEATURES

Depositional processes, exposed beds, extrusive features, intrusive features.

6. EXTRA-TERRESTRIAL PHENOMENA

Meteors, meteorites and associated features, astronomy, aurora borealis.

II. TERRESTRIAL ECOSYSTEMS

A. Communities

Both vegetable and animal communities will be discussed in terms of their significance and value assessed according to interpretative suitability. Speciation and individuals may be included under this heading. Zoological and ecological analysis of communities existing in the parks fall under this heading.

B. Energy Transfer Cycles and Processes

Energy transfer is displayed with the use of food chains and food webs emphasizing the niche of representative species which can be

portrayed by explaining the niche of species. Universal cycles will be portrayed under this heading using representative sites, i.e. element, biochemical, geochemical, biogeochemical cycles. Species niche will include predation, parasitism and social behaviour where applicable.

C. Succession

Ecotones will be discussed under this heading. Many individual species not discussed under communities will fall under Succession due to habitat requirements. Vegetation is the base, i.e. the producers. Therefore there will be more description of vegetation with associated fauna fitted into the story line of succession.

D. Adaptation

Specific adaptive features of species which are peculiar to areas or ecosystems will be discussed here. Adaptation is an extremely varied subject and, as such, may be included under other topic headings or may be dealt with individually under this heading. The inclusion of adaptation as a separate heading provides flexibility to the format of this report.

III. FRESHWATER ECOSYSTEMS

A. Communities

Due to the physical nature of lakes, rivers and ponds, four divisions of communities for lentic and lotic ecosystems exist.

1. LITTORAL COMMUNITY

Includes the region, where light reaches the bottom, with organisms such as rooted plants. Description of organisms in this community may appear under Succession in Freshwater Ecosystems due to obvious involvement with that process.

2. LIMNETIC COMMUNITY

Exists in the open-water zone which extends to the depth of effective light-penetration. The organisms found in this community would include plant and animal plankton and the nekton.

3. PROFUNDAL COMMUNITY

Lies below the depth of effective light penetration. Organisms typical to this zone are anaerobic bacteria and fungi.

4. BENTHIC COMMUNITY

Exists at the bottom surface and in the bottom ooze. Illustrations in the Appendices display these community areas. Description of organisms under this heading will be equivalent to communities under Terrestrial Ecosystems.

B. Energy Transfer Cycles and Processes

The portrayal of niche by using food webs and food chains will be discussed here. The same areas covered in the Terrestrial Ecosystems section will be included here.

C. Succession

Freshwater succession involves the aging of lakes (oligotrophic - mesotrophic - eutrophic - dystrophic) and associated processes such as marsh successions and the fauna of marsh areas. Waterfowl may be discussed here or under Communities or, as individuals, under Energy Transfer Cycles and Processes, or under Adaptation. The placement of organisms under particular headings depends on their relationship to the principles involved under each heading. This system affords flexibility essential to the format of interpretative planning and future growth.

D. Adaptation

As in Adaptation under Terrestrial Communities, individual adaptive features of significance will be discussed here.

IV. HUMAN IMPACT

This topic includes all actions of Man which alter natural processes or environment. Included here are construction, pollution, hunting pressures, etc. Man's role or niche may be shown here in relationship to the niche of significant organisms discussed in both Terrestrial and Freshwater Energy Transfer Cycles and Processes.

Figure 1 shows the themes and sub-themes for Asessippi Provincial Park.

NATURAL REGION DESCRIPTION

WESTERN UPLAND REGION #7

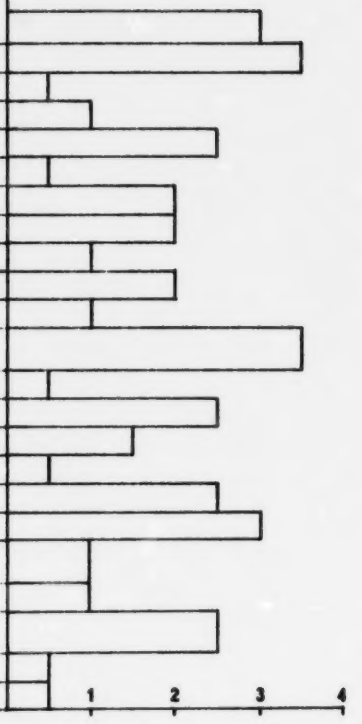
Asessippi is characterized by high relief. This rise separates the Shell and Assiniboine River valleys from the nearly level plain below formed by glacial Lake Agassiz. The bedrock consists of Mesozoic shales and sandstones, and outcrops are commonly seen. Glacial till covers the area and supports the two main types of vegetation: aspen-spruce boreal forest and mixed grass prairie.

Since the Shellmouth Dam created an impoundment known as Lake of the Prairies, four types of water ecosystems now exist: a lake, a river, several streams and springs. Physiographic history and Man's impact on the land constitute the major interpretive theme of Asessippi, a before-and-after look at a changing landscape, featuring esker formations, river valleys, the Shellmouth Dam and Reservoir, Asessippi village and the adaptation of freshwater and terrestrial organisms to a changed environment.

FIGURE 1

ASESSIPPI THEMES AND SUB-THEMES

Themes		Sub-themes		
I. Land Forms and Processes	A. Geology	1. Bedrock	a. Riding Mountain Formation	
	B. Geomorphology	1. Glaciation	a. Tills	
			b. Esker Formations	
			c. Stagnant Moraine	
			d. Outwash Plain	
			e. Erratics	
		2. Fluvial	a. Misfit River	
			b. Terraces	
			c. Mass Wasting	
		3. Hydrology	a. Surface Runoff	
			b. Water Table	
II. Terrestrial Ecosystems	A. Terrestrial Communities	1. Floral Communities	a. Prairie	
			b. Aspen	
			c. Minor	
		2. Faunal Communities	a. Insects	
			b. Reptiles and Amphibians	
			c. Avifauna	
			d. Mammals	
	B. Energy Transfer	1. Aspen Parkland	a. Food Web	
			b. Thermal Transfer	
	C. Adaptation	1. Floral	a. Grasses	
		2. Faunal	a. Invertebrates	
			b. Vertebrates	



RELATIVE % INTERPRETATIVE SIGNIFICANCE

FIGURE 1--Continued

Themes		Sub-themes		
III. Freshwater Ecosystems	A. Freshwater Communities	1. Lentic	a. Assiniboine and Shell Rivers	
		2. Lotic	a. Lake of the Prairies Impoundment	
IV. Human Impact	A. Native Influence	1. Fauna		
		2. Flora		
	B. Agriculture	1. Destruction of Native Prairie	a. Grazing	
			b. Improved Pasture	
			c. Cultivation	
			d. Nursery	
	C. Asessippi Townsite			
	D. Shellmouth Dam	1. Effects of Construction	a. Gravel Pits	
		2. Effects of Flooding and	a. on the Floodplain	
			b. on the Shell River	
		3. Creation of Lake of the Prairies	a. Lentic-lotic Transition Physical Changes	
			b. Phytoplankton	
			c. Higher Aquatic Flora	
			d. Invertebrate Fauna	
			e. Vertebrate Fauna	

1 2 3 4

RELATIVE % INTERPRETATIVE SIGNIFICANCE

THEME CLASSIFICATION

Theme status[1] was identified by estimating the degree of representation the theme and/or sub-theme possessed for interpretation by using the interpretative suitability criteria below.

i. Interpretative potential and feasibility of story line, complexity, applicability to theme, quality.

ii. Representativeness, completeness of story line, regionalism, recurrence.

iii. Emotional impact, aesthetic value, visitor experience.

iv. Accessibility.

v. Durability, regenerative capacity, viability.

vi. Uniqueness, protection.

vii. Feasibility of applying interpretative methodology.

Table 1 shows the themes and sub-themes.

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[1]Theme status = the percentage representation for interpretation.

TABLE 1

ASESSIPPI THEMES AND SUB-THEMES

Themes		Sub-themes		
I	A	1	a	i
I. Land Forms and Processes	A. Geology	1. Bedrock	a. Riding Mountain Formation	i. Millwood Member
	B. Geomorphology	1. Glaciation	a. Tills	i. Soil Profile
				ii. Lennard Till
			b. Esker Formations	
			c. Stagnant Ice Moraine	
			d. Outwash Plain	
			e. Erratics	
		2. Fluvial	a. Misfit River	
			b. Terraces	
			c. Mass Wasting of Valley Walls	
		3. Hydrology	a. Surface Runoff	i. Streams and Gullies
			b. Water Table	i. Springs
II. Terrestrial Ecosystems	A. Terrestrial Communities	1. Floral Communities	a. Prairie	
			b. Aspen	
			c. Minor	
		2. Faunal Communities	a. Insects	
			b. Reptiles and Amphibians	
			c. Avifauna	
			d. Mammals	
	B. Energy Transfer	1. Aspen Parkland	a. Food Web	
			b. Thermal Transfer	
	C. Adaptation	1. Floral	a. Grasses	
		2. Faunal	a. Invertebrates	
			b. Vertebrates	

TABLE 1--Continued

Themes		Sub-themes		
I	A	1	a	i
III. Freshwater Ecosystems	A. Freshwater Communities	1. Lentic	a. Assiniboine and Shell Rivers	
		2. Lotic	a. Lake of the Prairies Impoundment	
IV. Human Impact	A. Native Influence	1. Fauna		
		2. Flora		
	B. Agriculture	1. Destruction of Native Prairie	a. Grazing	
			b. Improved Pasture	
			c. Cultivation	i. Flora
				ii. Fauna
			d. Nursery	
	C. Asessippi Townsite			
	D. Shellmouth Dam (Lake of the Prairies)	1. Effects of Construction	a. Gravel Pits	
		2. Effects of Flooding	a. On the Floodplain	i. Marsh Habitat
				ii. Floodplain Habitat
			b. On the Shell River	i. Mudflat Community
		3. Creation of Lake of the Prairies	a. Lentic-Lotic Transition Physical Changes	i. Fluctuating Water Levels
				ii. Water Detention
				iii. Thermal Stratification
				iv. Dissolved Oxygen
				v. Inundates Soils
				vi. Chemical Composition
			b. Phytoplankton	
			c. Higher Aquatic Flora	
			d. Invertebrate Fauna	
			e. Vertebrate Fauna	i. Fish
				ii. Waterfowl
				iii. Furbearers

NATURAL HISTORY THEMES

I. LAND FORMS AND PROCESSES

A. Geology

1. BEDROCK

a. Riding Mountain Formation

i. MILLWOOD MEMBER

Asessippi Provincial Park is underlain by shales of the Riding Mountain Formation.[1] Extensive fluvial erosion, leading to the creation of the Shell and Assiniboine River valleys has graded these rivers through the underlying shale bedrock. The shale outcrops are more apparent wherever flora and associated soils have not obscured them.

The thick shales which were deposited during the Cretaceous Sea inundation, about 70 million years B.P., were the latest and one of the most widespread ancient sediments deposited on the surface of southern Manitoba and, therefore, were the ones most extensively eroded during the Cenozoic Era. Gradually, over the 50-million-year period prior to glaciation, most of the Cretaceous and Jurassic rocks, last of the present Manitoba Escarpment, were carried away by rivers. The Manitoba Escarpment, in fact, marks the easternmost edge of the bulk of the remaining Cretaceous rocks in the Province. One of the main reasons

[1] B.B. Bannatyne, The Clays and Shales of Manitoba. Mines Branch Publication 67-1. (Winnipeg: Manitoba Department of Mines and Natural Resources, 1970).

for the high elevation of the land to the west of the Escarpment is the presence of the resistant Odanah Shale which has formed a protective cap over underlying softer shales. Once this cap was eroded, the softer shales beneath could be removed fairly easily down to levels of the Red River valley and the Interlake.[1]

B. Geomorphology

1. GLACIATION

a. Tills

i. SOIL PROFILE

Soil profiles are evident along the valley walls where slumping has occurred. A prominent example is along the north slope of the Shell River, NNW of the main beach and pavilion. In addition, the numerous gravel and sand pits within the park are excellent sites for observing soil profiles. A pit between the park office and the maintenance buildings on the Upland area is of exceptional interpretative quality.

The Souris gravel and sand is the only one thought to be of pre-Wisconsin age whereas the younger units (Shell Till, Roaring River Clay, Minnedosa Till, Lennard Till) are considered to range in age from Early to Late Wisconsin.

ii. LENNARD TILL

The late Wisconsin Lennard Till forms the surface deposit over much of the Assiniboine Plain, where it is draped over pre-existing topography.

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[1] B.B. Bannatyne, S.M. Ringrose, and Dr. J.T. Teller, "Manitoba Before the Ice Age." Chapter 1 of "Manitoba's Heritage and Natural History," ed. Dr. J.T. Teller. (Unpublished manuscript, 1973).

Lennard Till was deposited by the last continental glacier that flowed across this region in a south-easterly direction and is inferred to represent a "classical Wisconsin" advance following a short, non-glacial period that began at least 40,000 to 22,000 years B.P.

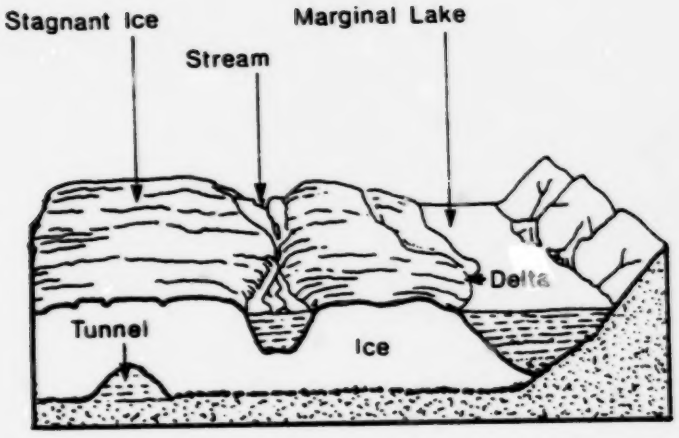
b. Esker Formations

Disappearance of the ice from the Wisconsin Ice Age uncovered long narrow ridges of coarse sands and gravels, extending in a sinuous course for miles, roughly parallel with north-south flow of ice. These features are eskers, the bed load deposits of the sub-glacial meltwater streams that emerge from tunnels at the ice margin (Figure 2). Some eskers are traceable for tens of kilometres with few interruptions and may receive tributary eskers, much as streams do.

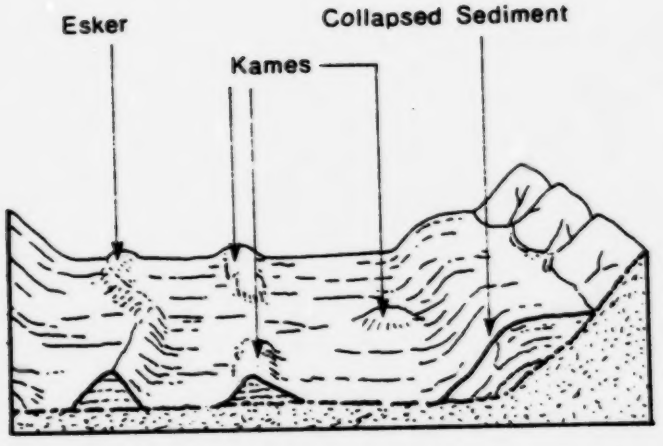
Eskers traverse the full width of the park on both sides of the Shell River valley but are most prominent in the south-eastern corner of the park. The northern low-lying eskers are less prominent probably because of extensive erosion due to continual agricultural practices.

c. Stagnant Ice Moraine

The advance and retreat of a great ice sheet leaves a host of distinctive minor land forms. They can best be understood and described with the aid of block diagrams, one showing the ice sheet in place and the other showing the landscape after the ice has disappeared. In Figure 2, Block A, the ice has reached a stable line of advance and is beginning to melt away in place. Debris held within the ice is dropped in place as the ice wastes away. Figure 3 depicts this process. The physiography of the upland areas of Asessippi Provincial Park may be partially due to this action.



A

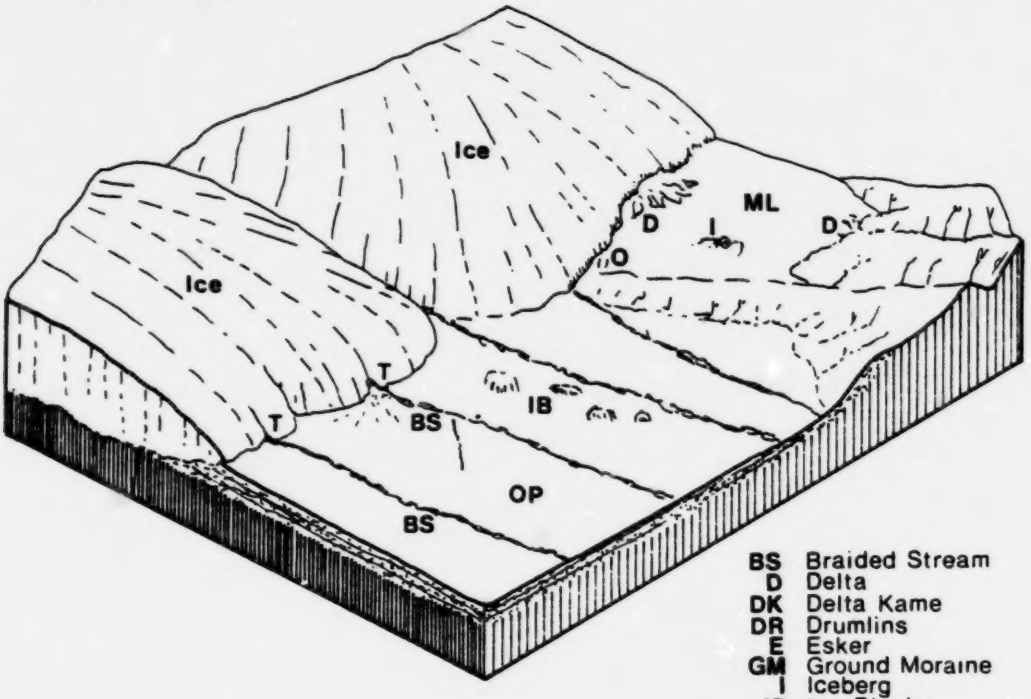


B

FIGURE 2

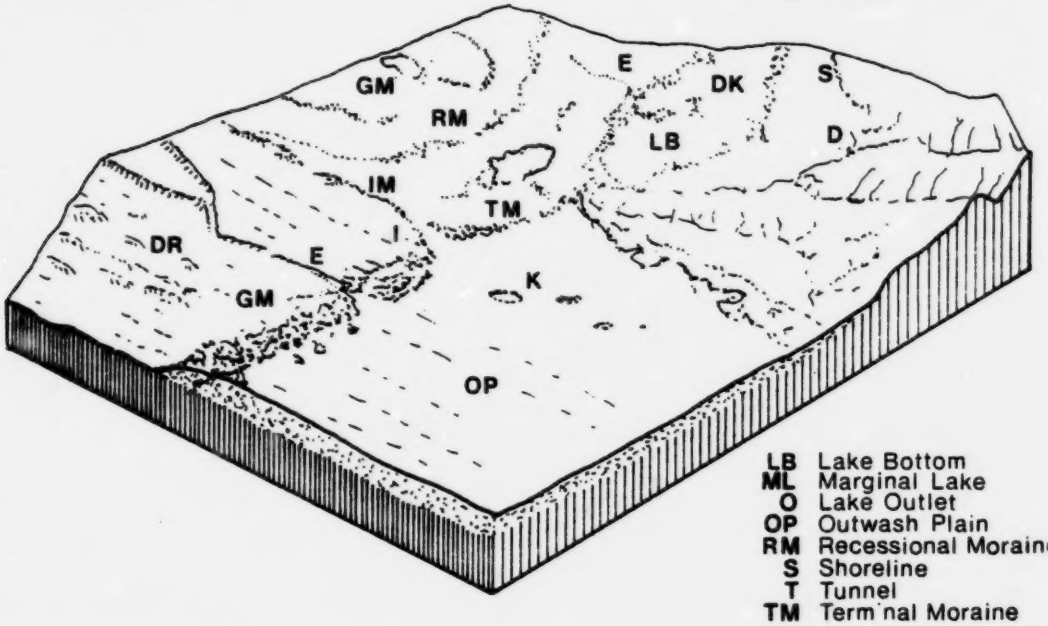
ESKER FORMATIONS

A. Almost Stagnant Ice Margin



BS Braided Stream
D Delta
DK Delta Kame
DR Drumlins
E Esker
GM Ground Moraine
I Iceberg
IB Ice Blocks
IM Interlobate Moraine
K Kettle

B. Subglacial Forms



LB Lake Bottom
ML Marginal Lake
O Lake Outlet
OP Outwash Plain
RM Recessional Moraine
S Shoreline
T Tunnel
TM Terminal Moraine

FIGURE 3

LANDFORMS PRODUCED NEAR THE MARGIN OF AN ICE SHEET

d. Outwash Plains

A large outwash plain extends south from the Shell and Assiniboine River valleys. The plain is gently rolling and has braided esker formations.

From the stagnant ice the meltwater issues in numerous streams, some discharging from tubes within and beneath the ice (eskers), others flowing down the ice surface itself (Figure 2, Block B).

During the continual deposition of sand and gravel carried by meltwater numerous ice blocks as large as houses were left behind on the plain by the decomposing glacier. Here the outwash material was piled around on the downstream side of the ice block. When the ice block finally melted a depression with a pile of gravel on its downstream side was left. The hole left behind by the melted ice block is known as a kettle. Depressions such as this in the plain favour growths of aspen poplar due to the higher moisture levels.

Outwash plains such as the 1.6-kilometre-square plain found within Asessippi are excellent sources of gravel, hence the numerous gravel pits on the southern upland area.

e. Erratics

Erratics can be seen on the Sipwa Interpretive Trail. Although most erratics are derived from a bedrock source not too far away, some have been transported extremely long distances by glaciers. As the ice sheets crept southwards during the height of the Ice Age they pushed and carried with them large quantities of pulverized rock and rubble. A layer of this material, the hard granite rock of the northern Shield country, was deposited over what is now Asessippi Provincial Park.

These granitic rock fragments are termed erratics because they do not conform to the area's geology. The southerly flow of the Keewatin Ice Sheet transported the granite from the Canadian Shield to the north. The upland region and the Assiniboine and Shell River valley walls are littered extensively with granitic rocks and boulders.

2. FLUVIAL

a. Misfit River

The Shell and Assiniboine are both examples of misfit rivers.

As the Keewatin Ice Sheet melted torrents of water spilled from its surface and from within. These streams combined to become huge rivers such as the Shell and Assiniboine. The erosive force of the large volumes of water moving along these rivers carved a path of least resistance through south-western Manitoba (Figure 4). The Shell River added water to the Assiniboine at Asessippi. Eventually, the Assiniboine found its way to the meltwater lake, Lake Agassiz, that formed at the foot of the ice sheet in southern Manitoba. Since the land is higher in the south the accumulating waters were dammed and a large glacial lake was formed. The Assiniboine Spillway was a major contributor to the volume of Lake Agassiz.

As the glacier melted enormous quantities of material were transported by rivers several times larger than the present Shell and Assiniboine Rivers. This well-sorted alluvium formed the valley deposits of sand, silt and gravel of the Assiniboine and Shell Rivers.

The Assiniboine and Shell Rivers probably ceased flowing with such force about 8,500 years B.P. As a result, high eroded valleys that had been created were now occupied by rivers a trickle of their former selves, thus the term, misfit river.

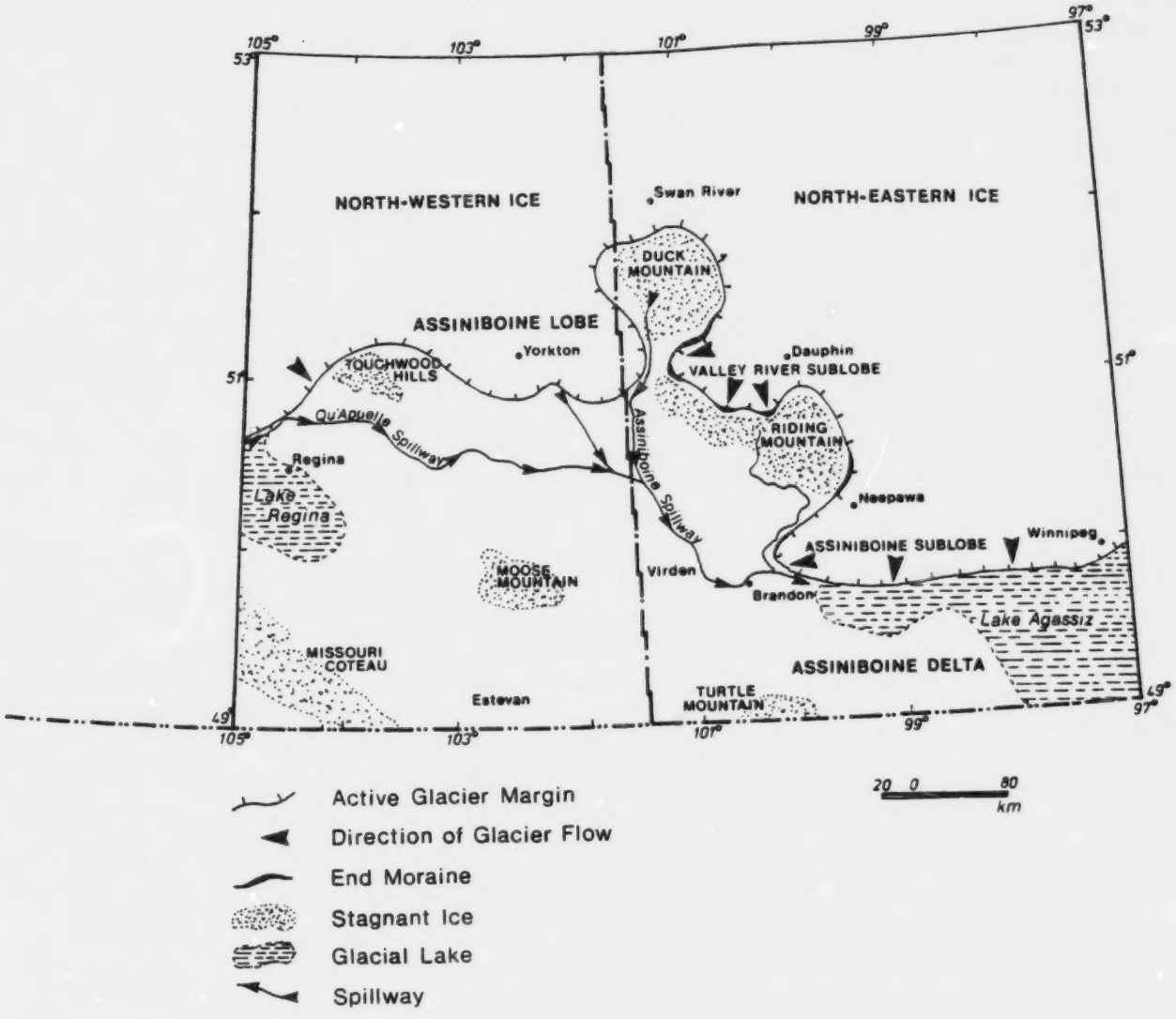


FIGURE 4

GLACIAL GEOLOGY OF MANITOBA

b. Terraces

There are three prominent terraces within the boundaries of Asessippi. Of the first terrace, the pavilion marks its northern descending edge, while a park access road marks its southern ascending edge. Gravel and sand are the principal alluvial outwash deposits.[1] The second and third terraces are both actually in the same location. They are found at the east end of Asessippi Provincial Park, bordered somewhat by the old P.T.H. 83 to the west and the northern and western slopes of the Shell River.

Essential steps in the evolution of alluvial terraces are illustrated in Figure 5. In Block A a valley is showing being filled with alluvium by an aggrading stream until the valley floor is broad and flat. Cause of aggradation may be due to change to a more arid climate but, in this case, from a greatly increased load derived from a melting glacier in an upland region.

In Block B the stream has begun to cut into the alluvial deposit, at the same time shifting laterally. Now formed is a single terrace whose surface is the remnant edge of the original floodplain and whose boundary on the valley margin is created by steeply descending scarps carved by meanders.

In Block C of Figure 5 degradation has proceeded further, and a series of alluvial terraces, resembling a flight of stairs on the valley wall, have been carved out.

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[1] B.B. Bannatyne, S.H. Ringrose, and Dr. J.T. Teller, "Manitoba Before the Ice Age." Chapter 1 of "Manitoba's Heritage and Natural History," ed. Dr. J.T. Teller. (Unpublished manuscript, 1973).

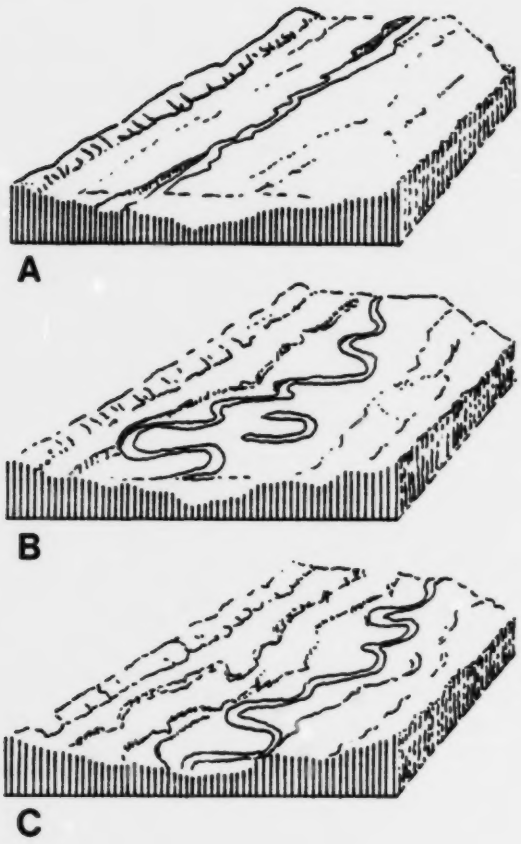

FIGURE 5

FORMATION OF ALLUVIAL TERRACES

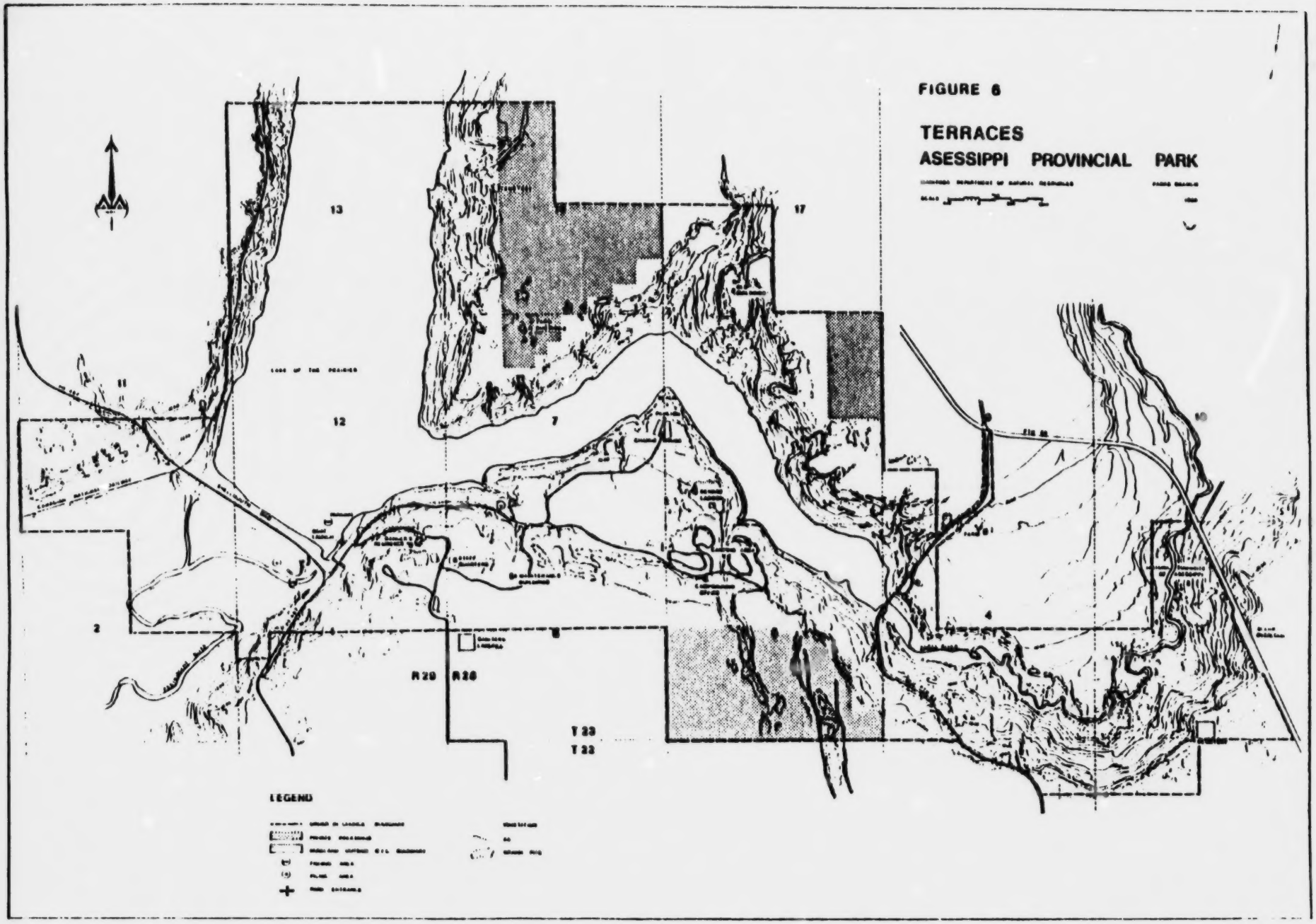
FIGURE 6
TERRACES
ASESSIPPI PROVINCIAL PARK
13
17
11
12
7
2
4
R 29
R 28
T 23
T 23
LEGEND

c. Mass Wasting of Valley Walls

Mass wasting and erosion of valley walls is an active process in Asessippi Provincial Park. Dumping and creeping are the two most active processes, and these would be much more severe if not for the presence of vegetation which stabilizes the walls. Ground water, emerging as springs in the valley walls, also contributes to the slumping.

3. HYDROLOGY

a. Surface Runoff

i. STREAMS AND GULLIES

Numerous streams have eroded their paths down the valley walls. Due to the intermittent nature of this runoff, gullies scar the faces of the valley walls when conditions are wetter.

Prominent gullying is apparent on the north slopes of the Shell River valley.

b. Water Table

Extensive down cutting in the creation of the Assiniboine and Shell Rivers has bisected the region's water table.

i. SPRINGS

Spring-fed streams of ground water flow out of the valley walls. These streams are intermittent and are characterized by variable velocity, depending on the height of the prevailing water table.

There are two springs on the south slope of the Shell River valley. The first emerges just north of the maintenance buildings. The second is due east of the first and its stream runs through the campground to the reservoir. The high ground-water level is also responsible for slumping of valley walls. The stream running through the campgrounds activates

mass wasting along the Shell River valley in the vicinity of the spring.[1] The pavilion was initially constructed on cliffs where a portion of the beach is today. The weight of its foundations and movement of heavy machinery caused this portion of the cliff to slump. A new pavilion was then located well back of the valley wall on stable ground.[2]

II. TERRESTRIAL ECOSYSTEMS

A. Communities

1. FLORAL COMMUNITIES

a. Prairie Communities

i. FESCUE PRAIRIE

Sites S-1-23-29

S-5-23-28

S-6-23-28

Fescue prairie occurs where the average annual precipitation exceeds 37.5 cm., which is more than that required by mixed prairie.

The dominant grass is rough fescue (*Festuca scabrella*). Important subdominants are june grass (*Koeleria cristata*) and the speargrasses (*Stipa* sp.). The bluegrasses, (especially *Poa pratensis*), which withstand grazing well have become fairly abundant at certain sites. Also present are northern wheat-grass (*Agropyron dastachyum*) and western wheat-grass (*Agropyron trachycaulum*). In disturbed areas, such as around badger holes, smooth brome grass (*Bromus inermis*) has become established.

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[1]Doug Donald, Park Ranger, Dauphin, Department of Mines, Natural Resources and Environment. Personal communication, 1978.

[2]William Roper, Park Ranger, Dauphin, Department of Mines, Natural Resources and Environment. Personal communication, 1978.

On steep slopes, especially the south-facing sides of small drains, blue gramma (*Bouteloua gracilis*) is fairly abundant along with the speargrasses.

Sweet grass (*Hierochloe odorata*) may be locally abundant at the bases of these drains.

Other plants include prairie wild rose (*Rosa arkansana*), field chickweed (*Cerastium arvense*), hoary puccoon (*Lithospermum canescens*), showy locoweed (*Oxytropis splendens*), prairie crocus (*Anemone patens*) and three-flowered avens (*Geum triflorum*). Also abundant are the goldenrods (*Solidago* sp.), yarrow (*Achillea millefolium*), the sages (especially *Artemesia frigida*), and northern bedstraw (*Galium boreale*).

On well-drained slopes bearberry (*Arctostaphylos uva-ursi*) and the small spikemoss (*Selaginella densa*) occur.

Scattered patches of western snowberry (*Symphoricarpos occidentalis*), wolf willow (*Elaeagnus commutata*) and stunted saskatoon (*Amelanchier alnifolia*) are present.

A more extensive list of species is included in the Appendices. Additions to this list are expected.

Fescue prairie intergrades with mixed prairie in Asessippi Provincial Park. Plants of the true prairie (tall grass prairie) such as the blue-stem are relatively rare in the park. Almost pure stands of rough fescue may be found in some spots. Aspen succession has begun on the fescue prairie in Asessippi due to the absence of fire.

ii. UPLAND MIXED PRAIRIE

This community is dominated by blue gamma. Subdominants are the speargrasses (*Stipa comata, Stipa spartea*). This community is present along the crest of the northern face of the Shell

River valley and on steep slopes adjacent to the fescue prairie. Its most distinct expression is along a series of braided eskers located just outside the park (S.W. 1/4-5-23-28). A fairly good example of this community in the park is on the crest of a steep slope of a gorge in the terminal moraine deposit just north of the esker ridges.

In many places this community intergrades with the fescue community. On the esker ridges rough fescue is only a minor component. Abundant forbs in the spring are prairie crocus, three-flowered avens and the low everlasting (*Antennaria aprica*). Many of the forbs in the fescue prairie are also abundant. These are showy locoweed, alpine milk-vetch (*Astragalus alpinus*) hoary puccoon, and golden aster (*Chrysopsis villosa*). On steep slopes the small spikemoss and moss phlox (*Phlox hoodii*) serve as an important soil-binding understory. Wild onion (*Allium textile*), harebell (*Campanula rotundifolia*) and Indian breadroot (*Psoralea esculenta*) are in flower in the summer. The sages (*Artemesia* sp.), the goldenrods, yarrow and wild bergamot (*Monarda fistulosa*) bloom in the autumn.

On the western slope, (opposite the Shellmouth dam, S-11-23-29), the prairie lily (*Lilium philadelphicum*) is fairly abundant. Here also the hairgrass (*Agrostis scabra*) has become fairly abundant.

b. Aspen Communities

i. MATURE CLOSED FOREST

Mature closed forest is found in a nearly continuous band along the southern side of the Shell River valley.

The upper stratum of the community is composed of trembling aspen (*Populus tremuloides*) along with the black or balsam poplar

(*Populus balsamifera*). Balsam poplar may form nearly solid stands in wetter areas. Scattered throughout is the paper birch (*Betula papyrifera*).

The shrub stratum varies throughout the forest. In moist spots, (such as near the two springs running down the south slope near the campgrounds and the picnic ground, willows (*Salix* sp.) are the major shrubs of the understory. One commonly occurring is the false mountain willow (*Salix pseudomonticola*). Throughout the remainder of the forest the beaked hazelnut (*Corylus cornuta*) is the most abundant shrub of the understory. Red-ozier dogwood (*Cornus stolonifera*) is locally abundant in moist areas. Near the edges of this community abundant shrubs are the saskatoon, choke-cherry (*Prunus virginiana*) and highbush-cranberry (*Viburnum trilobum*).

Common plants of the understory are wild sarsaparilla (*Aralia nudicaulis*), violets (*Viola* sp.), false Solomon's seal (*Smilacina stellata*), wild lily-of-the-valley (*Maianthemum canadense*), and wild strawberry (*Fragaria virginiana*). In drier areas wild raspberry (*Rubus idaeus*) is abundant.

ii. ASPEN SCRUB COMMUNITY

The aspen scrub community is abundant along the northern slope of the Shell River valley (Sections 3 and 4, 23, 28), as well as in isolated patches within the fescue prairie.

In the fescue prairie they consist of scrubby stands of trembling aspen with a broken understory of western snowberry. False Solomon's seal, and licorice root (*Glyceria lepidota*) occur in the understory along with bluegrasses.

c. Minor Communities

These communities are of limited extent within the park or are near the northern limit of their ranges and thus poorly represent specific community types.

i. SCRUB OAK COMMUNITY

This community is abundant along the northern hills along the Shell River valley (Sections 7, 8, 23, 28) and also in the north-western corner along ridges.

The most abundant tree is the bur oak (*Quercus macrocarpa*). There is a fairly open understory consisting mainly of bluegrasses. Border shrubs of the poplar community may also be present in this community.

ii. DECIDUOUS FLOOD PLAIN COMMUNITY

This community is located along the Assiniboine River both below the Shellmouth dam (N.W. 2-23-29) and near the old Asessippi townsite (N.W. 3-23-23).

The most abundant tree is Manitoba maple (*Acer negundo*). Abundant plants of the understory are wild raspberry, tall meadow rue (*Thalictrum polygamum*), stinging nettle (*Urtica dioica*) and false Solomon's seal. Near the old townsite the understory is composed mostly of bluegrasses and smooth bromegrass.

iii. WILLOW COMMUNITIES

The sandbar willow (*Salix interior*) borders the upper Shell River. Further from the river an intermittent band of red-ozier dogwood lies between the willow and the aspen communities. Few herbs grow within the dense willow thickets.

Sandbar willow may also be found between the flood-plains community (below the Shellmouth dam) and the Assiniboine River.

The spring-side community dominated by false mountain willow is part of the mature aspen community as mentioned above. A species list for this community is included in the Appendices.

iv. MUD-FLAT COMMUNITY

A mud-flat community is found at the mouth of the Shell River (near the bridge across old P.T.H. 83). Most abundant plants are the cattail (*Typha latifolia*) and slough grass (*Beckmannia syziachne*). The Baltic rush (*Juncus balticus*) and manna-grass (*Glyceria striata*) are also important. Many buttercups (*Ranunculus* sp.) are present. A species list is included in the Appendices.

2. FAUNAL COMMUNITIES

a. Insects

i. PRAIRIES

Within the grasslands the most noticeable insects are the grasshoppers. Species which may be seen in the park are the two-striped grasshopper (*Melanoplus bivitatus*), the red-legged grasshopper (*Melanoplus sanguinipos*), the clear-winged or roadside grasshopper (*Camnulla pellucida*), and Packard's grasshopper (*Melanoplus packardi*).

The clouded locust (*Encoptolophus sordidus*) and green grasshoppers (*Chortophagus* sp.) may also be commonly seen.

The field cricket (*Gryllus pennsylvanicus*) is another important grassland insect and is a predator on grasshoppers and other pests.

Other insects that lay their eggs in the ground and feed on grasses are the cutworms, wireworms and army-worms.

The wireworms and cutworms eat the roots, seeds and lower stems of plants, while the army-worms crawl out of the ground and eat leaves and flowers.

Important cutworms are the red-backed cutworm (*Euxoa ochrogaster*), the white cutworm (*Euxoa scendens*) and the striped cutworm (*Euxoa tessellata*).

One of the most important wireworms is the prairie grain wireworm (*Cetenicera aeripennis*)

An important army-worm is the Bertha army-worm (*Mainestra conifigurata*). Another important insect of the prairies is the June lacettes, the white grubs of which are numerous in the soil.

A butterfly characteristic of the prairie is the black swallowtail (*Papilio polyxenes asterius*).

Ants are abundant in natural prairie. Most abundant are *Myrica scabinodis* and *Lasius brevicornis*.

Reference material on insects is included in the Appendices.

ii. WOODLANDS

Insects of the woods include the wood-boring beetles and the tent caterpillars. The poplar boring beetle (*Saperda calcerata*) weakens the host and enables some fungi to attack the tree. The fall web-worm (*Matacosma disstria*) may be very abundant some years and strip the trees of their leaves.

b. Reptiles and Amphibians

A common reptile of Asessippi Provincial Park is the red-sided garter snake (*Thamnophis sirtalis parietalis*). This species frequents a variety of habitats: ponds, marshes, streams, woods and prairie.

Some of the common amphibians inhabiting the streams and marshes are the leopard frog (*Rana pipiens*) and boreal chorus frog (*Pseudacris triseriata*).

The prairie sections of the park offer favourable habitat to the plains spadefoot toad (*Scaphiopus bombifrons*) which can adapt to a drier environment, and to the leopard frog and bull snake (*Pituophis melanoleucus sayi*).

c. Avifauna

Due to the high degree of habitat diversity in this park a great variety of birds exist in a small area.

This park offers ideal habitat for both sharp-tailed (*Pedioecetes phasianellus*) and ruffed grouse (*Bonasa umbellus*). Both are abundant. There is a sharp-tailed grouse dancing ground near the garbage dump south of the maintenance compound.

Other important seed-eaters in the prairie community include chipping sparrow (*Spizella passerina*), song sparrow (*Melospiza melodia*), prairie horned lark (*Eremophila alpestris*), American goldfinch (*Spinus tristis*) and mourning dove (*Zenaidura macroura*). In the winter the common redpoll (*Acanthis flammea*) and the snow bunting (*Plectrophenax nivalis*) may feed on vegetation projecting above the snow.

The insectivorous birds important in this habitat are clay-coloured sparrow (*Spizella pallida*), vesper sparrow (*Pooecetes gramineus*), meadowlark (*Sturnella neglecta*), prairie horned lark, upland plover (*Bartramia longicauda*), brown-headed cowbird (*Molothrus ater*), yellow-shafted flicker (*Colaptes auratus*) and the killdeer (*Charadrius vociferus*). The purple martin (*Progne subis*), barn (*Hirundo rustica*),

cliff (*Petrochelidon pyrrhonota*) and bank swallows (*Riparia riparia*), nighthawks and kingbirds feed on flying insects.

Sharp-tailed grouse and some birds of prey [such as the sparrow hawk (*Falco sparverius*)] also feed heavily on insects, especially grasshoppers.

Birds of prey include the marsh hawk (*Circus cyaneus*) and Swainson's hawk (*Buteo swainsoni*). Others possibly nesting in the park are the red-tailed hawk (*Buteo jamaicensis*) and American kestrel (*Falco sparverius*). The short-eared owl (*Asio flammeus*) may be expected in the prairie. The great horned owl (*Bubo virginianus*) may nest or feed in the park. Goshawks (*Accipiter gentilis*), sharp-shinned (*Accipiter striatus*) and rough-legged hawks (*Buteo lagopus*) are uncommon but may be seen. Ospreys (*Pandion halioetus*) and turkey vultures (*Cathartes aura*) are occasionally seen.

Birds of the forested areas such as rose-breasted grosbeaks (*Pheucticus ludovicianus*) warblers, shrikes, vireos, kingbirds and thrushes may also be present. Woodpeckers seen in the park include the downy woodpecker (*Dendrocopos pubescens*)and the yellow-bellied sapsucker (*Sphyrapicus varius*).

Birds of stream-side habitats (flood-plain and willow communities) may include the veery, the yellow-throats, some warblers and the catbird (*Dumetella carolinensis*).

Birds play an important part in the aquatic habitats as well. Grebes, terns and, perhaps, mergansers are fish-eating birds which can be expected in the park. Pelicans (*Pelecanus erythrorhynchos*) are seen during migratory periods. The great blue heron (*Ardea herodias*) and

the belted kingfisher (*Megaceryle alcyon*) would be expected to feed in the running water of the Shell River. A great blue heron rookery has been reported at the upper end of the reservoir. Herons cover a large area while feeding.

Many ducks may be seen during spring and fall migration, but few nest in the park due to a lack of good habitat and stable water levels. See the Appendices for further information.

d. Mammals

i. PRAIRIE

A common small mammal in the prairie sections of the aspen parkland was the meadow vole (*Microtus pennsylvanicus*). This vole, along with the deer mouse (*Peromyscus maniculatus*), is to be expected in the matted vegetation of the unburned and ungrazed grassland. Wrigley[1] indicated that the thirteen-lined ground squirrel (*Citellus tridecemilineatus*) occurs in moist grassland throughout south-western Manitoba.

In the short grass prairie of the uplands, in overgrazed and mown areas, colonies of Richardson's ground squirrels (*Citellus richardsoni*) are expected to occur. Also, probably present in this habitat is the prairie vole (*Microtus ochrogaster*). Wrigley[2] indicated this vole does not share ranges with the meadow vole.

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[1] R.E. Wrigley, Animals of Manitoba, (Winnipeg: Manitoba Museum of Man and Nature, 1974).

[2] Ibid.

Another possible small mammal is the northern pocket gopher (*Thomomys talpides*), which Wrigley[1] reported at densities of up to 10 per hectare on mesic prairie. This mammal is seldom seen. Piles of dirt excavated by the pocket gopher are often attributed to moles.

Dens of the American badger (*Taxidea taxus*) are fairly abundant in the fescue prairie west of the maintenance compound. This species feeds on Richardson's ground squirrel and other small mammals. Another important prairie mammal numerous in the park is the white-tailed jack-rabbit (*Lepus townsendii*). These animals are best seen at dusk, as their activity is primarily nocturnal.

The short-tailed weasel (*Mustela erminea*) is indigenous to the upland short grass community. This mammal exerts a control over the numbers of voles and may attack birds or destroy birds' nests.

ii. WOODLAND

In the poplar woodland the most abundant small mammal is probably the red-back vole (*Clethrionomys gapperi*). Wrigley[2] found this animal most abundant in forested areas and less so in mixed savanna and mesic prairie. This mammal shows marked population cycling and may be found in marginal habitats during years when numbers are high.

Franklin's ground squirrel (*Citellus franklini*), also known as the bush gopher, was seen near the pavilion in the park. These animals inhabit thickets of choke-cherry and aspen. Wrigley[3] suggested that

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[1] Ibid.

[2] Ibid.

[3] Ibid.

though fairly rare throughout the south-western part of Manitoba, these ground squirrels may be locally abundant in certain areas. Asessippi Provincial Park may be one of those areas. Also to be expected in woodlands is the red squirrel (*Tamiasciurus hudsonicus*). Fairly large numbers can be expected in the bur oak community, in which these mammals prefer to nest at the southern limit of their range.

The gray squirrel (*Sciurus carolinensis*) has expanded its range west since its first appearance in the Red River valley in 1930. Wrigley[1] suggested that this species will continue to expand westward along river-bottom forests. It may also be found in the bur oak community.

The white-tailed deer (*Odocoileus virginianus*) is abundant throughout the park and is often flushed from aspen bluffs in the fescue prairie. Important overwintering areas for this species exist within the park. Much of the park is poor habitat due to extreme slopes and resultant sparse vegetation. The very dense poplar-hazel forest west of the old P.T.H. 83 offers abundant browse and cover. This is the only abundant large mammal in the park.

The only natural predator of the white-tailed deer which occurs within the park is the coyote (*Canis latrans*). On very rare occasions coyotes have been observed to take yearlings.

Raccoons (*Procyon lotor*), striped skunks (*Mephitis mephitis*) and porcupines (*Erethizon dorsatum*) are to be expected in the park. The omnivorous skunk may play an important part in the prairie ecosystem. Red foxes (*Vulpes fulva*) are also present.

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[1] Ibid.

The beaver (*Castor canadensis*) was once abundant along the willow-fringed streams of south-western Manitoba. A lodge was observed in the vicinity of the old Asessippi townsite. A number of dams are present on the Shell River west of the townsite. The actions of beaver affect the level of the Shell River and thus exert an influence over the aquatic ecosystem. Beaver which inhabit river banks are also found in the reservoir.

Since there are no marsh areas within the park it is unlikely that the muskrat (*Ondatra zibethica*) occurs here. Such habitat may develop through aquatic succession on present mud flats (see Succession below).

B. Energy Transfer

1. ASPEN PARKLAND

a. Food Web

i. PRAIRIE COMMUNITY

Here are biotic interaction (co-action) and food chain relationships. The dominant grasses and subdominant herbs of the prairie support a large population of insects and voles and a smaller one of gophers and ground squirrels. These animals feed directly on the plants and in turn support insectivorous birds, frogs, and such carnivores as the badger, coyote and red-tailed hawk. The badger, in digging out ground squirrels, its favourite food, throws up mounds of earth which kill the grass and form starting places for patches of *Symphoricarpos* which, in turn, may enable aspen seedlings to take root and thus hasten the advance of the forest on the prairie. On the other hand, the work of snowshoe hares (*Lepus americanus*) on the forest's edge is tending to check this spread.

Figure 7 illustrates the biotic interaction (co-action) within the prairie communities. Arrows point from the animals or plants eaten to those that eat them. Dominants are in capitals underlined, subdominants in capitals, predominants with every second letter underlined and influents in small letters.

ii. ASPEN COMMUNITY

The plants support a large number of herbivorous animals which in turn support a population of insectivorous and carnivorous species. The most influential species is the beetle (*Saperda calcerata*) which, by its borings in the mature trees and the subsequent enlargement of the holes by woodpeckers, forms inroads for attack by the white heart rot of aspen which causes premature death of the trees. The snowshoe rabbit in the forest's edge is very important in girdling and killing many shrubs and young aspens, thus checking their spread on the prairie. The great horned owl is a sub-influent carnivore which feeds not only on the birds and mammals of the forest but also hunts over the prairie and sloughs.

Figure 8 illustrates the biotic interaction (co-action) within the aspen communities. The forest-edge community is separated from the mature forest by a broken line. Arrows point from the animals or plants eaten to those that eat them. Dominants are in capitals underlined, subdominants in capitals, predominants with every second letter underlined and influents in small letters.

C. Succession

1. PRAIRIE TO ASPEN

The zone of transition from forest to prairie (an ecotone) is marked by a number of shrubby plants, such as saskatoon, choke-cherry,

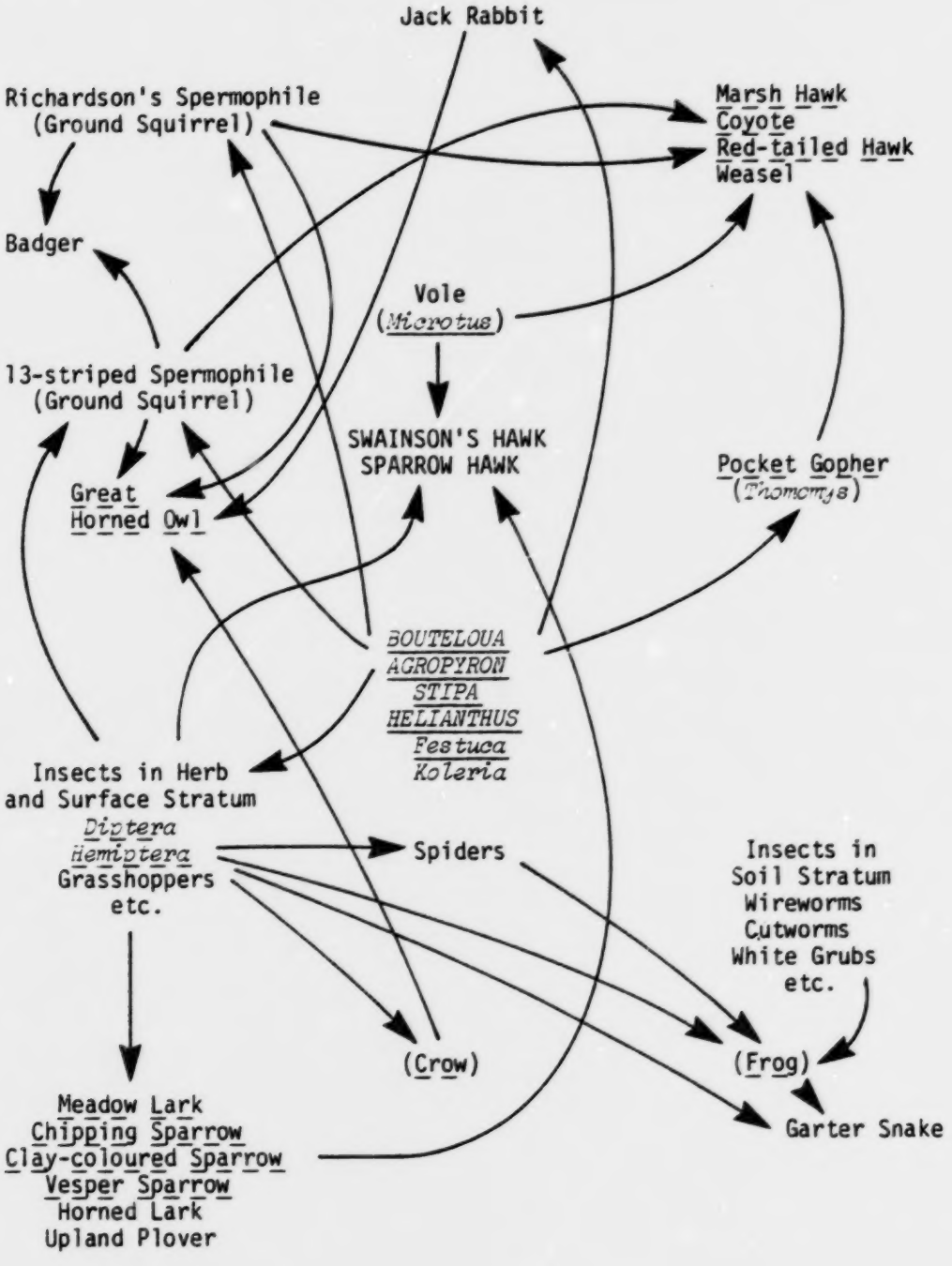

FIGURE 7

BIOTIC INTERACTION AND FOOD-
CHAIN RELATIONSHIPS ON THE PRAIRIE

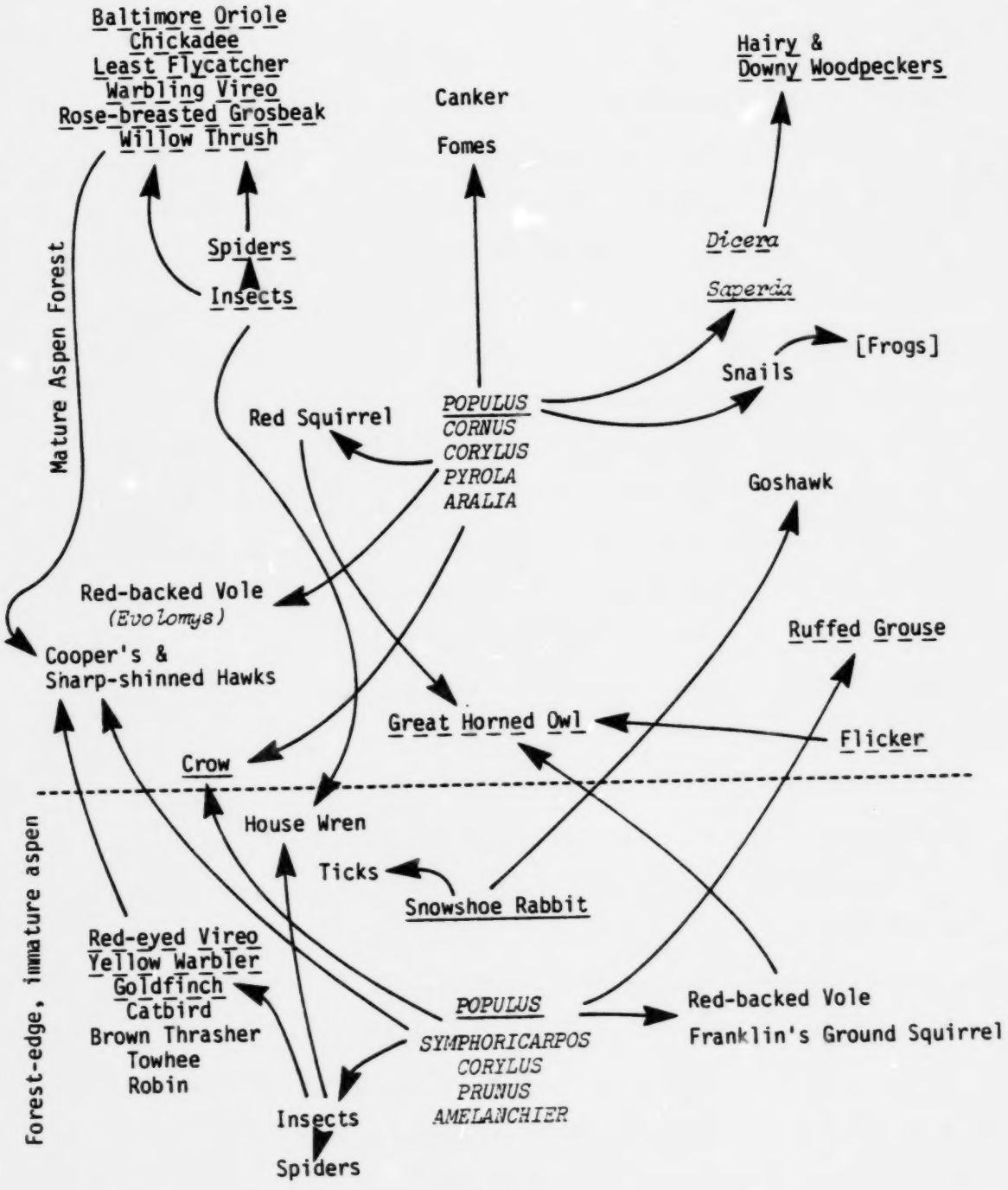

FIGURE 8

BIOTIC INTERACTION AND FOOD-CHAIN
RELATIONSHIPS IN THE ASPEN COMMUNITIES

high-bush cranberry and hazel. Some of these, and other shrubs, may become established within the prairie proper if for some reason the competitive ability of grasses is reduced.

Some shrubs such as trembling aspen, saskatoon, choke-cherry, snowberry (*Symphoricarpos albus*) and wolf willow may rapidly establish themselves within the prairie if the turf is disturbed.

Studies of such shrubby communities indicate that the establishment of shrubs is hindered mainly by the superior competition for moisture, light, nutrients and so on of grasses, which prevents seeds from germinating, and the establishment of shrubs.

Once established many of these shrubs, e.g. trembling aspen and wolf willow, can spread by means of rhizomes to form extensive patches.

i. MICROCLIMATE AND TOPOGRAPHY

Succession is influenced by microclimate and topography.

The more moisture-loving of these shrubs frequently spread along ravines or from seedlings which have become established in low-lying areas. These include hazel, saskatoon, choke-cherry and snowberry.

On southern slopes of hills of not too steep a grade the humidity is higher, evapotranspiration lower and available soil moisture greater. Fine soils such as alluvial deposits of clay retain more moisture and enable such shrubs to spread.

The more xerophytic shrubs, such as a second species of snowberry (*Symphoricarpos occidentalis*), wolf willow and trembling aspen, frequently become established on northern slopes as well. Such clumps can be seen throughout the fescue prairie.

ii. FAUNA

Wolf willow, in addition to snowberry, aids in the establishment of aspen. It forms extensive patches in the prairie and spreads by means of long rhizomes. Although it grows in a more open stand than snowberry it competes successfully with grass. It is fed on by deer and cattle and probably was also eaten by buffalo. These mammals may have aided in the dispersal of the seeds, but the main means of dispersal is probably by wind detaching the berries and rolling them across crusted snow during the winter.

Snowberry fruits are a favoured food of sharp-tailed grouse. Seed dormancy is broken by passage through this bird's digestive tract. Seeds of trembling aspen are small and wind dispersed. There usually are seeds of shrubs almost anywhere on the prairie awaiting a chance to begin growth.

The turf may also be broken by burrowing mammals such as badgers, Richardson's ground squirrels, pocket gophers or moles. Snowberry may become established in these disturbed areas. Burrowing mammals benefit from the increased cover provided. Abandoned burrows within such patches are favoured denning sites for coyotes and red foxes.

Within such patches of snowberry seedlings of trembling aspen become established. Spreading by means of rhizomes large poplar clones are formed.

Formerly large patches of turf were disturbed at sites of buffalo wallows. Snowberry established itself in such sites.

iii. FIRE

Prairie fires retard the process of succession. Shrubs are less able than the grasses to withstand the effects of fire. Grass

rhizomes are underground and their meristems are located close to the ground, thus protecting these perenating organs from the heat of a fire.

Fire is often used to rejuvenate overgrazed pastures invaded by snowberry, wolf willow or sages.

Annual or very frequent fires are probably detrimental to the establishment of snowberry. This is further evidence of the importance of fires in limiting the extent of the parkland through the checking of forest succession.

The grass stem is hollow. This enables the inflorescence to be held high from the ground with the least investment in structural tissue. The solid nodes give the stem structural strength and may also contain turgescent tissues which raise the stem from a horizontal position after wind-storms, hail or trampling.

The growing points of meristems of the stems and leaves are located close to the earth, enabling the stem or leaf to renew growth after close grazing or fire. The narrow and small number of grass blades reduces water-loss and increases the photosynthetic area.

Two forms of growth in grasses are exemplified by bunchgrass and sod-forming rhizomatous grass. Bunchgrasses are often adapted to growth in drier soils, and have shallow, widespreading and finely-divided roots. A good example of this form of growth is seen in blue gramma. Some of the sod-forming rhizomatous grasses are adapted to growth in fairly moist soils and have deeply penetrating root systems. An example of this is rough fescue. Others are adapted to grow in dry soil and have shallower, widespreading roots.

Rhizomes are specialized underground stems at the nodes of which new shoots are developed. This enables rapid colonization by a few

seedlings of such open areas as gravel pits. Brome grass has well-developed rhizomes and is a colonizer of vacant habitats in many places throughout the park.

Most grasses are highly specialized plants. Some, such as big bluestem (*Adropogon gerardii*), grow best on heavy clay soils, others, such as blue gramma, like coarse or sandy soil. Some, such as rough fescue, like moderately wet weather, others, such as blue gramma, like it dry. Some bluegrasses thrive in shade, others (rough fescue, blue gramma, speargrasses), prefer full sunlight. Some (slough grass and *Phragmites*) even grow in sloughs.

Many grasses grow most rapidly in the spring, when moisture is abundant, and then lie dormant in the hot dry summer. Moisture-loving grasses such as sweetgrass flower in the spring (late May) while blue gramma, a more xerophytic grass, flowers later in the season.

2. FAUNAL SUCCESSION

a. Invertebrates

Adaptations for prairie habitation include a covering of wax to retain body moisture in a relatively dry environment, laying of eggs in a waterproof covering in the ground and a diet of grass. Some species of grasshopper with restrictive food habits, such as the Rocky Mountain grasshopper (*Melanoplus spretus*) are adaptable only to native prairie habitat. With the destruction of this natural prairie as a result of settlement this species became extinct. After settlement other species of grasshopper adapted to the changes in habitat because they had a more varied diet.

b. Vertebrates

Many species of birds adapt well to the environment of Asessippi Provincial Park. Aspen forests provide ideal camouflage for such birds as grouse and hawks. Many of the passerines, such as the evening grosbeak (*Hesperiphona vespertina*), have beaks suited for seed cracking and are able to forage in the aspens' roots.

The coyote and fox use the shelter provided by the snowberry bushes for denning sites. The fruit of the snowberry is the winter food of the pine grosbeaks (*Pinicola enucleator leucura*).

The badger's adaptations enable it to dig underground in bare areas in the aspen forest or the prairie fields. The long hard claws of the forefeet, the short powerful legs and the low-slung body are specializations for digging. The colour of its fur blends well with the dried grasses.

White-tailed deer are a very adaptable species. Their foraging habits and unrestricted diet allow them to feed in various habitats. They prefer a wet area that supports nutritious vegetation, but they are also commonly found on farm land and wind rows. Since white-tailed deer can tolerate high levels of disturbance, the deer population of Asessippi remained excellent in spite of the reservoir and the resultant reduced capability of the area to support it.

It was found that after the impoundment was created movement of the white-tailed deer from one side of the valley to the other was restricted. Since the vegetation on the western slopes is adapted to a more moist habitat (birch, alder) and that on the eastern slopes to a drier habitat (shrubs, grasses), the restriction of movement by the reservoir limits the variation in the white-tailed deer's diet.

III. FRESHWATER ECOSYSTEMS

A. Communities

1. LENTIC ECOSYSTEMS

a. Assiniboine and Shell Rivers

Accompanying the flooding of the Assiniboine and Shell Rivers were dynamic processes transforming aquatic habitats. Water levels rose and created a lacustrine environment. The Assiniboine and Shell Rivers in Old Age, characterized by wide valleys, extensive meandering and oxbow lakes, were drowned by accumulating waters. The Pleistocene glacial melt channel through which the rivers meandered became natural embankments retaining water from the flow. This impoundment took on the characteristics of a lake, and the freshwater communities may therefore have had characteristics of both rivers and lakes during this time. At present there is no relevant information available, so what is presented here is a standard freshwater ecosystem with outlines of a few of its basic components and ecosystems.

The relatively still waters of lakes and ponds offer environmental conditions that contrast sharply with running water. Depending upon turbidity light penetrates only to a certain depth. Temperatures vary seasonally and with depth. Because only a relatively small portion of the water is in direct contact with the air and because decomposition (standard for all standing bodies of water) takes place on the bottom, the oxygen content of lake water is relatively low compared to that of running water. Oxygen content may become less with depth. These gradations of oxygen, light and temperature profoundly influence life in the lake, its distribution and adaptions[1] (see Appendices).

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[1] R.L. Smith, Ecology and Field Biology. 2nd ed. (New York: Harper and Row, 1974), p. 850.

2. LOTIC ECOSYSTEM

a. Lake of the Prairies Impoundment

Lakes can be divided into two basic layers--the trophogenic zone and the lower tropholytic zone. In the trophogenic zone, photosynthesis dominates since sunlight is absorbed up to that depth. This layer has a small but variable temperature gradient. In the lower and much colder tropholytic zone decomposition is most active and the drop in temperature is gentle. Between the two layers lies the compensation depth at which photosynthesis balances respiration and beyond which light penetration is so low that it is no longer effective.

TABLE 2

CHARACTERISTICS OF LACUSTRINE LAYERS

Zones		Energy	Life Forms
TROPHOGENIC	Littoral (shallow-water)	Light Penetrates Bottom	Rooted Plants: Water Lilies, Rushes, Sedges
	Limnetic (open water)	Extends to Depth of Light Penetration	Phytoplankton, Zooplankton, Fish, Diatoms and Desmids
TROPHOLYTIC	Profundal (beneath thermocline)	Below Light Penetration Energy Source Derived from Organic Material from Upper Layers	Organism Diversity Influenced by Oxygen and Temperature
BENTHIC (common to trophogenic and trophaytic)		Oxygen Deficient	Anaerobic Bacteria Mud Surface: Flatworms Mud Burrowers: *Psidium* (Clams), Rhizopods, Phantom Midges, Crustacea, Protozoa

Common to both layers is the benthic, or bottom,region. All of these layers are closely dependent upon one another in nutrient cycles and energy flow. In the benthic zone oxygen is rapidly depleted. Therefore, water leaving the lake by way of a river system is highly anaerobic. In 1974 Dr. J. O'Connor[1] noted the occurrence of a large fish kill extending 2.4 kilometres downstream from the Shellmouth Dam on the Assiniboine River. He credited the occurrence to the explosive blooms of blue-green algae in the Lake of the Prairies. Thus, lakes with highly productive limnetic and littoral zones have a decrease in organism diversity but not necessarily a decrease in numbers. (See the Appendices for a list of benthos).

IV. HUMAN IMPACT

A. Native Influence

1. BISON BONES

The Plains Indians once occupied the area known as Asessippi Provincial Park.

Buffalo were essential to their way of life, and numerous sites of bisons' bones along the north wall of the Shell River valley, north north-west of the beach and pavilion areas, suggest this area may have been used as impoundments for bison drives. The Appendices provides a description of how these drives were carried out.

2. MAINTAINING NATIVE PRAIRIE

It is speculated that the native influence on the natural history of Asessippi Provincial Park was minimal. If they used fire to aid their bison drives this may have helped maintain the prairie areas that exist today.

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[1]Dr. J. O'Connor, Fisheries Biologist. Personal communication, 1974.

B. Agriculture

Agricultural activity is still evident in Asessippi Provincial Park.

The southern uplands were principally used as a forage area for cattle due to the extensive glacial till found only a few inches below the soil. The northern uplands, slightly more suitable for agriculture, exhibit the recent scouring of ploughs.

1. DESTRUCTION OF NATIVE PRAIRIE

a. Grazing

Prairie species vary in their ability to withstand grazing. While rough fescue does not flourish under close grazing, blue gramma and the blue grasses increase. Such unpalatable species as pasture sage and snowberry increase at the expense of palatable species.

The relative importance of some species is expected to change now that grazing has been largely discontinued in Asessippi Provincial Park.

b. Improved Pasture

S.E. 1/4 7, 23-28

N.W. 1/4 1, 23-29

N.E. 1/4 2, 23-29

There are two large patches of improved hayland in the park. One of these is on the bench land north-east of the campground. The other is on the lowlands beneath the Shellmouth Dam. On the former field poplar seedlings or suckers can be seen moving into the hayland. Also present are many prairie species such as hoary puccoon, sweet grass, and blue-eyed grass (*Sisyrinchium montanum*).

On the lowland section adjacent to the maple flood-plain community dense patches of Manitoba maple seedlings are becoming established. Sweet clover is also abundant in this section.

At both sites alfalfa and brome grass are predominant. The importance of these species may decrease as succession proceeds.

c. Cultivation

Evidence of past agricultural activities in Asessippi Provincial Park are the remains of a farm in the northern upland region.

i. FLORA

Cultivation completely removes the native species in areas affected and replaces it with cereal crops such as wheat, oats and barley.

ii. FAUNA

Destruction of virgin prairie has greatly reduced the numbers of thirteen-lined ground squirrels.

Grasshoppers with restrictive food habits have been adversely affected by destruction of native prairie. The best example of this is the Rocky Mountain grasshopper. By 1902, subsequent to the breaking of the prairie and the extermination of the buffalo, this species, the scourge of Manitoban farmers in the late 1800's, became extinct.

Other grasshoppers which have benefited from habitat changes since settlement and have become major agricultural pests include the two-striped grasshopper, roadside grasshopper and Packard's grasshopper.

Bison were extirpated from this area due to the massive slaughtering and subsequent cultivation of virgin prairie that occurred throughout the prairies.

Pronghorn antelope have disappeared from the area and mule deer are a rare occurrence.

d. Nursery

The nursery property on the southern face of the Shell River valley, by the old P.T.H. 83, was extensively cleared of indigenous vegetation.

Dotting the nursery landscape are the many introduced species of plants, including apple and plum, conifers such as pine and spruce, and currant bushes.

C. Asessippi Townsite

The townsite of Asessippi is on the Shell River in N 1/2 3-23-28 in the eastern corner of Asessippi Provincial Park.

In 1883 a joint stock company was formed under the heading of the "Shell River Colonization Company" under Plan One of The Dominion Lands Act (1881 Revision). Alloted to the Company were Townships 23 and 24 in Range 28 and Township 23 in Range 29, West of the Prime Meridian (Res. Inv.: 36).

From the Company's petition to the Governor-in-Council and various reports to Colonization Company Inspection it was noted that Asessippi had:

i. a permanent mill dam,
ii. a flour mill,
iii. a store and Post Office,
iv. a blacksmith's shop,
v. a pump and cabinet factory,
vi. a saw and shingle mill,
vii. a hotel,
viii. a warehouse,
ix. two private dwellings, and
x. a bridge across the Shell River near the dam.

The establishment of the townsite has left its legacy on the natural environment. At present very little evidence in structural form remains to depict prior settlement. However, successional forces are slowly reforesting the area cleared at one time for new development.

D. Creation of the Shellmouth Dam and Lake of the Prairies

1. EFFECTS OF CONSTRUCTION

a. Gravel Pits

N.E. - Section 1-23-29

N.W. - 1/4 Section 6-23-28

A fairly extensive section of the fescue prairie was removed to obtain gravel during the construction of the Shellmouth Dam in 1972. Prairie species have since then recolonized the bare gravel. Legumes, with their ability to survive in impoverished substrate are numerous. Examples are showy locoweed, buffalo bean (*Geoprumnon crassicarpum*) and various vetches. Also abundant in some spots are alfalfa, sweet clover and brome grass. Many mosses characteristic of disturbed areas have also become established.

The gravel pit near the beach pavilion now serves as a sewage lagoon.

2. EFFECTS OF FLOODING

a. Loss of Flood-plain Habitat

i. MARSH HABITAT

Valley bottomlands which were flooded by the Shellmouth Reservoir contained a marsh complex (temporary ponds, oxbows, channels of the Shell and Assiniboine Rivers and a shallow lake). These wetlands attracted a variety of breeding marsh birds and some migrants. They also constituted good habitat for muskrat and mink (*Mustela vison*).

The impoundment created by the Shellmouth Dam has substantially less capability for production of waterfowl and fur-bearers than the marsh habitat it inundated.

ii. FLOOD-PLAIN FORESTS AND MEADOWS

The flood-plain forests and meadows inundated by the impoundment had the following capabilities for producing white-tailed deer:

84% or 7,275 hectares had above average (class 3 or higher);

37% or 3,259 hectares were potential winter range; and

22% or 1,930 hectares were class I W (highest class 2 winter range. Carrying capacity was judged at 588 to 855 deer or an average of 6.6 to 9.6 deer per square kilometre).

It was, therefore, some of the best habitat for white-tailed deer in the Province. Although an excellent population of white-tailed deer still exists, the overall capability of the area to produce these deer has decreased.

Also flooded were the level benchlands which in the winter months had some attraction for sharp-tailed grouse in their search of berries and mast. Ruffed grouse and other woods-loving wildlife would also lose habitat to floods.

b. Effect on the Shell River

The Shell River is the largest tributary of the Assiniboine in the vicinity of the impoundment. The river's course extends more than 160 kilometres and terminates at the Assiniboine River about 0.8 kilometres north of the Shellmouth Dam.

Only the lowest end of the river within the confines of Asessippi Provincial Park will be appreciably disturbed by the higher water levels of the impoundment. If anything, this should encourage more use of this

part of the river by fish.[1] Native game species like northern pike (*Esox lucius*), walleye (*Stizostedion vitreum*) and yellow perch (*Perca flavescens*) will likely congregate at its lower end and provide opportunity for angling.

i. MUD-FLAT COMMUNITY

The mud-flat community located at the mouth of the Shell River is affected in its successional process. Many of the species found there, such as slough grass and fowl manna grass, occur naturally along slough and lake margins at various stages of aquatic succession.

A cattail marsh may develop at this site in the future. Such species as red-winged blackbirds (*Agelaius phoeniceus*) could be expected to move into such new habitat. A sandbar willow community existed here before the land was cleared for flooding. Old stumps can still be seen in the water. A similar community may or may not re-establish itself with time. Development of submerged and emergent aquatic plants has been hindered by large annual fluctuations in water levels.

3. CREATION OF LAKE OF THE PRAIRIES

Differing in several aspects from natural lakes of comparable size, many impounded waters are very productive during their first years of establishment when fish and other aquatic life flourish. This may be due to an unsettled balance of species which are attempting to stabilize in response to the changes occurring.[2]

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[1] A.N. Fedoruk, Shellmouth Designated Reservoir Area: Proposed Land Use Plan. Canada Land Inventory Project. Report #7. (Winnipeg: Manitoba Department of Mines and Natural Resources. A.R.D.A. May 1969), p. 114.

[2] Ibid.

The fluctuating water level, which is necessarily raised and lowered over a greater distance than in most natural lakes, imposes certain limitations on the biological productivity of the impounded waters. These changes in water-level may be not only catastrophic for aquatic fauna but also may disturb the physical and chemical characteristics of the water so that environmental conditions are seriously affected.

a. Lentic-Lotic Transition

The creation of the Lake of the Prairies, an impoundment, by the completion of a dam at Shellmouth has had significant impact on aquatic ecology. Flooding of the Assiniboine River, and its tributary the Shell River, has caused the change of a lentic to a lotic ecosystem. The maximum depth of the newly formed reservoir is 10.5 metres.

As the current was slowed down with the construction of the Shellmouth Dam a noticeable change took place. Silt and decaying organic matter accumulated on the bottom, and fine detritus from upstream became the main source of energy. Faunal organisms are able to move about to obtain their food, and a plankton population of sort develops. The composition and configuration of the stream community approaches that of standing water.[1]

With increasing temperatures, decreasing currents and accumulating silt, organisms of flowing waters are replaced gradually by organisms adapted to these conditions. Where the current is at a minimum many of the resident fish lack the strong lateral muscles characteristic of

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[1] R.C. Smith, Ecology and Field Biology. 2nd ed. (New York: Harper and Row, 1974), p. 850.

lentic species. They have compressed bodies that permit them to move with ease through masses of aquatic plants. Molluscs, particularly *Sphaerium* and *Pisidium*, and pulmonate snails, crustaceans and burrowing mayflies replace the rubble-dwelling insect larvae.

As the volume of water in the impoundment increases, as the current becomes even slower and the silt deposits heavier, the number of feeders on detritus increases. Tube-dwelling annelids (worms) and midges are common, as are the bottom-feeding catfish, suckers and carp. Back-swimmers, water-boatmen and diving beetles inhabit the sluggish stretches and backwaters of rivers; and where conditions are suitable, pike and turtles are common. Rooted aquatics appear. Emergent vegetation grows along the river banks, and duckweeds float on the surface. Indeed, the whole aspect approaches that of lakes.

The higher water temperature, weak current and abundant decaying matter promote the growth of protozoan populations and other plankton. Scarce in fast water, plankton increase in numbers and species in slower water.[1] Rivers have no typical plankton of their own. Those found there originated mainly from backwaters and lakes.

i. FLUCTUATING WATER LEVELS

The reservoir is subject to raised and lowered water levels. In particular areas a 0.3-metre drop in water level would have pronounced effects. Specifically, regions with a 5% slope would encounter as much as six metres of water recession.

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[1] Ibid.

According to Doherty and La Roi[1] fluctuating water levels exert a strong selective influence on the composition and structure of plant communities in the inundant zone. If fluctuations are frequent and of wide amplitude the affected shoreline may be virtually devoid of plant life. If they are only rarely wide and frequently of narrow amplitude, the affected shoreline may display vegetational zonation in accordance with the differential tolerances of species to the depth and duration of inundation, not unlike the inter-tidal zone of coastal waters.

ii. WATER DETENTION

Excessive growth of noxious algae and their degradational products represent the most advanced stage of lake eutrophication. Since water is held in the reservoir for indeterminable periods of time, this more advanced state of lake evolution can be artificially induced.

The input of nutrients to these "closed basins" over a long period of time, with little surface overflow, brings about a steady one-way accumulation of high quantities of plant nutrients and organic matter in lakes. The use of fertilizers and cattle farming, typical to south-western Manitoba, further intensify the natural process of eutrophication. A consequence of nutrient loading prevalent in the Shellmouth Reservoir is the development of the troublesome blue-green filamentous alga, *Aphanizomenon flosaquae*.

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[1] M.J. Doherty and G.H. La Roi, "Some Effects of Fluctuating Water Levels and Other Water Factors on Aquatic and Semi-aquatic Vegetation in Five Bodies of the Peace-Athabaska Delta, Alberta". Proceedings, Symposium on the Lakes of Western Canada. (University of Calgary, Water Resources Centre, 1973), pp. 202-227.

During July and August the Shellmouth Reservoir contains dense algal blooms which degrade the recreational potential of the lakes.[1] *Aphanizonemom flosaquae* reaches enormous densities during its blooming period. Winds funnelling through the valleys are responsible for concentrating blooms, thereby restricting bathing and angling capability in the park.

iii. THERMAL STRATIFICATION

A lake becomes stratified when layers of water at various depths do not mix with one another.

Temperature conditions in the lake are influenced by variables, e.g. volumes of inflow and outflow, climatic conditions of the region, the type of draw-off, the sudden introduction of flood waters with heavy loads of silt and the physical features of the basin. Minimal thermal stratification will be in spring, autumn and winter; it will be the greatest during summer, especially in areas 10.5 metres or more deep i.e. within 16 kilometres north of the dam itself.

iv. DISSOLVED OXYGEN

Water flowing in its grade-influenced course is continually subject to aeration due to the greater air-to-water interface. Standing bodies are characteristically anaerobic with increasing depth. Convectional flow is the principal source of aeration within a still water body.

The conditions of dissolved oxygen in the water are perhaps the most critical factor in establishing suitability of the reservoir for

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[1] William Roper, Park Ranger, Asessippi Provincial Park. Personal communication.

aquatic life, including the number and kinds of fish. Whether or not long-term oxygen deficiency of the water will be a problem in the Shellmouth Reservoir is not known. However, construction of the dam in 1972 to provide storage for 481,058 cubic decametres of water was followed by a major fish kill on July 6th.

Tests proved dissolved oxygen levels to be abnormally low at 4.4 and 4.0 p.p.m., or respectively 48% and 44% saturation. Fish in the reservoir exhibited symptoms of stress due to low oxygen levels. There was a putrid odour to the river and a bloom of *Aphanizomenon* near the southern end of the reservoir. Limnological surveys were also conducted. Results are presented in the Appendices.

Dissolved oxygen levels are sufficient to support native game fish such as northern pike, walleye, yellow perch, etc. However, low amounts of dissolved oxygen together with collapse of algal bloom result in further fish kills.

v. INUNDATED SOILS

The Shellmouth Reservoir flooded a vast expanse of surface substrate. Highly soluble chemical constituents of soils may alter the chemistry of the impounded water. More research is required.

vi. CHEMICAL COMPOSITION

The mineralized quality of the water may be due to the combined effects of geology, physiography and climate upon the watershed. The high nutrient levels are believed to result primarily from agricultural practices and natural leaching of soils and bottom sediments.

The Appendices provide more pertinent information from the sampling conducted in 1974 along the Assiniboine River below the dam.

Organic carbon is directly derived from the algal population. Therefore, days of high organic-carbon content corresponded with days when large numbers of *Aphanizomenon* filaments were present. Primary productivity was generally low due to the turbidity of the river which restricted penetration of light.

High nutrient levels have continued to cause severe algal blooms that restrict late-summer recreation in the reservoir.[1] Refer to the Appendices for the chemical conditions affecting algal blooms.

b. Phytoplankton

Plankton blooms occur during the summer months. The dominant species, *Aphanizomenon* sp., *Stephanodiscus* sp., *Daphnia* sp., *Cyclopidae* and *Centropagidae* are characteristic of reservoirs and indicative of polluted waters. The sudden die-off of over-populated *Aphanizomenon* and its subsequent rapid bacterial decay results in fish kills. What triggers the actual collapse of the bloom is not known yet; it may be a virus attack or a simple exhaustion of available nutrients due to overpopulation, or mechanical upswelling of anoxic and toxic bottom water by wind action. However, the fact that in three or four cases a new bloom of the same blue-green alga occurs within 2-3 weeks would indicate the latter possibilities.[2] Nevertheless, it is obvious that with the sudden die-off algae bring about a rapid biochemical

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[1] William Roper, Park Ranger, Asessippi Provincial Park. Personal communication.

[2] John Barica, "Changes in Water Chemistry Accompanying Summer Fish Kills in Shallow Eutrophic Lakes of Southwest Manitoba". Proceedings, Symposium on the Lakes of Western Canada. (University of Calgary, Water Resources Centre, 1973).

degradation of organic substances in the water surrounding the algae cells, resulting in a total depletion of oxygen and an extreme liberation of ammonia which, at the high pH values of lake water, can be present as non-dissociation toxin. This results in substantial mortality of fish in the Assiniboine River downstream from the reservoir.[1]

c. Higher Aquatic Flora

At the present time there is no inventory of higher aquatic vegetation. However, it is expected that with the projected nutrient level and reasonably clear waters a variety of aquatic plants may occur in the reservoir. The substratum, largely alluvial, would favour the establishment of many kinds of rooted plants. Drastic fluctuations in water level would prevent the establishment of vegetation, but some plants may be able to tolerate the reservoir if changes in water level are orderly. The "normal" drawdown from 421 to 417 metres is expected to be regular over the late autumn to late winter when exposed plants are dormant. Their perpetuity can only be maintained if water levels return to "normal" by the next growing season. For the most part, no new vegetation should become established on the exposed area (See the Appendices for Species list).

d. Invertebrate Fauna

In 1969 when the reservoir was formed the invertebrate fauna were survivors from river fauna. Much of the area now under water is organically rich. This fact, coupled with presumed satisfactory oxygen conditions, would favour the development of an abundant bottom

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[1] Inter-departmental Memorandum of July 18th, 1972, from W. Howard, Fisheries Biologist, to D.F. Stewart, Regional Director.

fauna. However, this fauna in shallow areas is especially vulnerable to disturbed water levels, and in deeper areas to silting.

As a result of changes in water level over the winter it is expected that almost the whole littoral zone, where the largest benthic production occurs, will be exposed. Aquatic insects such as dragonflies and mayfly nymphs, and some Chironomid larvae may attempt to move with the receding water but not very successfully. Some crayfish may be stranded, some may burrow and some may move with the water. The ultimate result may be the decimation, by exposure, of many species of invertebrates that attempt to become established in that year.[1]

It appears that *Gammarus* sp. may have become abundant in the Shellmouth Reservoir possibly because of a reduction in inter-specific competition and predation. Such specific abundance in various invertebrates at primary-consumer levels may alter faunal composition and densities at higher trophic levels in an energy-transfer series.

A feature of the development of benthic communities in new impoundments is the rapid colonization by *Chironomidae*.[2] The distribution of the fine material and its deposition as a layer of sediment is an important stage in the development of lake ecosystems.[3] Chironomid

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[1]A.N. Fedoruk, op. cit.

[2]A.J. McLaughlin and M.A. Cantrell, "Sediment Development and Its Influence on the Distribution and Tribe Structure of *Chetonomus plumosus* (Chironomidae, Diptera) in New Impoundments", Fresh Water Biology, 6(5) (1976), 437-443.

[3]A.J. McLaughlin and S.M. McLaughlin, "Development of Mud Habitat During the Filling of Two New Lakes", Fresh Water Biology, (6) (1976), 59-67.

larvae, an important food source of many, flourish in benthic environments having sediment greater than 2.6± 0.4 mm. thick.

e. Vertebrate Fauna

i. FISH

Since the Lake of the Prairies is eutrophic it would have the natural basis for supporting a productive fishery.[1] Fedoruk[2] suggests that the most important influences that would decide the outcome are the thermal stratification, the condition of oxygen in the hypolimnion and the food supply.

Fedoruk[3] presumed that the native species of the river are:

i.	*Esox lucius*	Northern Pike
ii.	*Stizostedion vitreum*	Walleye
iii.	*Stizostedion canadense*	Sauger
iv.	*Perca flavescens*	Yellow Perch
v.	*Hiodon alosoides*	Goldeye
vi.	*Hiodon tergisus*	Mooneye
vii.	*Ambloplites rupestris*	Rock Bass
viii.	*Ictalurus nebulosus*	Brown Bullhead
ix.	*Lota lota*	Burbot
x.	Family: *Catostomidae*	Suckers
xi.	*Cyprinus carpio*	Carp
xii.	*Acipenser fluvescens*	Sturgeon

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[1] A.N. Fedoruk, op. cit.

[2] Ibid.

[3] Ibid.

Rainbow Trout (*Salmo gairdneri*) occur below the dam (See the Appendices for detailed description of species).

Some fish may not be able to maintain their populations in impounded waters while others may multiply excessively.[1]

Native species introduced to the reservoir in 1969 are thought to be able to locate suitable spawning sites in the substratum, e.g. gravel terraces and benches, tributary streams with riffle areas, mud and grass flats, aquatic vegetation and debris, etc. Presuming satisfactory substrate and temperatures, spawning success of species such as walleye, saugers, northern pike, suckers, etc., which deposit eggs on the bottom and generally in shallow water is certain. However, fluctuation in water levels during the spawn would be detrimental to egg development.

The spawn of other native species may not be as vulnerable as that of northern pike and walleye. The eggs of mooneye and goldeye are not as closely tied to the bottom and may drift with changing water levels. Yellow perch, among other fishes, will likely spawn during the time when water levels are relatively stable. Many of these species, if they find the new environment satisfactory, should be able to spawn with a reasonable degree of success in the Shellmouth Reservoir.

Pickerel are being stocked at the Saskatchewan end of the reservoir and some undoubtedly migrate to Asessippi Provincial Park. No stocking has occurred at the Manitoban end[2] (See the Appendices for further information).

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[1] Ibid.

[2] Doug Donald, Senior Park Supervisor, Western Region. Personal communication.

ii. WATERFOWL

While the reservoir is used as a staging area by diving ducks and a greater number of geese, it has less attraction for breeding birds. For the most part, the Manitoban portion of this reservoir is a deep water-body with relatively steep offshore slopes providing few stands of emergent vegetation suitable for overwater nesters. Excessive depths severely restrict growth of submergent aquatic plants, and the steep wooded shoreline precludes establishment of a broad band of emergent and upland vegetation suitable for dry-land nesters and other breeding marsh birds.

iii. FURBEARERS

The number of muskrats has decreased due to the loss of habitat and the schedule of drawdowns. These animals, attracted by the large body of water, build their houses and store their winter food supplies during the autumn when the water level is stable, unaware that a drastic winter drawdown will leave them and their dwellings high and dry.

Beaver appear to be doing well in areas where aspen are still available.

Mink may also have suffered due to loss of habitat.

APPENDICES

TABLE 3

GEOCHRONOLOGICAL TIME SCALE

ERA	PERIOD	EPOCH	Beginning of Epoch in Millions of Years	PRINCIPAL LIFE FORMS	REVOLUTIONS & OROGENIES
CENOZOIC	QUATERNARY	Recent	0.011	Modern	
		Pleistocene	3.5	Development of Man	
	TERTIARY	Pliocene	12	Large carnivores, horses and elephants	CASCADIAN
		Miocene	26	Whales, bats, monkeys & horses	(Basin & Range)
		Oligocene	38	Grazing animals & abundant grasses	
		Eocene	54	Development of modern mammals	
		Paleocene	65	First placental mammals	
MESOZOIC	CRETACEOUS	UPPER	90	First flowering plants	LARAMIDE
		MIDDLE	120	Climax & extinction of dinosaurs & ammonites	NEVADIAN
		LOWER	136		
	JURASSIC	UPPER	150	First birds, first true mammals	
		MIDDLE	170	Many dinosaurs and ammonites	
		LOWER	190		
	TRIASSIC	UPPER	200	First dinosaurs and rapid development of reptiles	PALISADES
		MIDDLE		Abundant cycads & conifers	
		LOWER	225	Development of conifers	
PALEOZOIC	PERMIAN	UPPER	235	Spread of reptiles	APPALACHIAN
		MIDDLE	260		
		LOWER	280	Earliest reptiles	
	CARBONIFEROUS: PENNSYLVANIAN		320	Abundant insects	
	CARBONIFEROUS: MISSISSIPPIAN		345	Coal-forming forests Echinoderms abundant Sharks and Amphibians	
	DEVONIAN	UPPER	365		ACADIAN
		MIDDLE	390	First amphibians	
		LOWER	395		
	SILURIAN	UPPER			
		MIDDLE		First terrestrial plants	
		LOWER	435		TACONIC
	ORDOVICIAN	UPPER			
		MIDDLE		Primitive fishes	
		LOWER	490	First known vertebrates	
	CAMBRIAN	UPPER	510	First record of abundant marine life	
		MIDDLE	540	Trilobites & brachiopods dominant	
		LOWER	570		
PRECAMBRIAN ERA		LATE	1.6×10^9		Killarney Pepokean Algoman Laurentian
		EARLY	2.1×10^9		

NOTE: All dividing lines, dates, orogenies, etc. are approximately placed

TABLE 4

GEOLOGICAL FORMATIONS IN MANITOBA

Showing basic lithology and the range of depositional thickness

ERA	PERIOD		FORMATION (Group)	MEMBER	BASIC LITHOLOGY	THICKNESS (Feet)
Cenozoic	Quaternary	Recent			Soil, alluvial deposits, sand-dunes, bogs	
		Pleistocene			Glacial deposits	0-850
	Tertiary	Eocene to Pliocene Palaeocene	Not reported in Manitoba			
Mesozoic	Cretaceous		Turtle Mountain		Shale, sandstone, lignite	-480+
			Boissevain		Sand & sandstone greenish grey kaolinitic shale	100-150
			Riding Mountain	Odanah	Hard grey siliceous shale	-800+
				Millwood	Greenish bentonitic shale	50-500
			Vermilion River	Pembina	Non-calc. shale, bentonite beds	100-400
				Boyne	Calcareous speckled shale	
				Morden	Carbonaceous shale; septarian conc.	50-200
			Favel		Calc. speckled shale, limestone bands	60-130
			Ashville (Ashville Sand)		Non-calc. silty shale; 0.90 sand	120-370
			Swan River		Sand, sandstone, shale, clay, lignite	0-400
			Waskada		Varicoloured shale	0-160
			Melita		Varicoloured shale, calc. shale, limestone	340-480
			Reston		Argillaceous limestone & shale	0-170
			Amaranth	Upper; evaporite	Anhydrite, gypsum; shale, dolomite	0-170
				Lower: red beds	Dolomitic shale to siltstone, anhydritic	0-140

TABLE 4 (continued)

ERA	PERIOD	FORMATION (Group)	MEMBER	BASIC LITHOLOGY	THICKNESS (Feet)
Palaeozoic	Triassic Permian Pennsylvanian	Not reported in Manitoba except Permian? Lake St. Martin cryptoexplosion structure.			
	Mississippian	Charles		Dolomite and anhydrite	-120
		Mission Canyon		Limestone, dolomite, anhydrite, oil production	270-320
		Lodgepole	Whitewater Lake Virden Scallion Routledge	Limestone argillaceous and cherty; shale, oil production	480-580
		Bakken		Black shale and siltstone	10- 50
	Devonian	Qu'Appelle Group	Lyleton	Red dolomitic shale	35-180
		Saskatchewan Group	Nisku	Fossiliferous limestone & dolomite	40-140
			Duperow	Shaly limestone, dolomite, anhydrite, cyclical	400-640
		Manitoba Group	Souris River First Red	Limestone, evaporite, shale, cyclical	210-310
			Dawson Bay Second Red	Limestone, anhydrite, basal red shale	140-220
		Elk Point Group	Prairie Evaporite	Halite, with potash, anhydrite, dolomite	0-425
			Winnipegosis	Dolomite, reef & inter-reef	30-350
			Elm Point	High calcium limestone	0- 45+
			Ashern	Dolomite & shale, brick red	5- 60
	Silurian	Interlake Group		Dolomite	175-370
	Ordovician	Stonewall		Dolomite	30- 70

TABLE 4 (continued)

ERA	PERIOD	FORMATION (Group)	MEMBER	BASIC LITHOLOGY	THICKNESS (Feet)
Palaeozoic	Ordovician	Stony Mountain	Gunton Penitentiary Gunn	Dolomite, upper part shaly Argillaceous dolomite Fossiliferous calc. shale; red, grey, green	100-160
		Red River	Fort Garry Selkirk Cat Head Dog Head	Dolomite, minor limestone Dolomite limestone, mottled Domomite, cherty Dolomite, limestone, mottled	175-300
		Winnipeg		Quartzose sand, sandstone shale	0-220
	Cambrian	Deadwood		Glauconitic sandstone	?
Precambrian					

RESOURCE BASE: MICROPHYTES[1]

PHYLUM: CHLOROPHYTA

SUB-PHYLUM: CHLOROPHYCEAE

ORDER: TETRASPORALES

FAMILY: PALMELLACEAE

Sphaerocystis schroeteri

ORDER: ULOTRICHALES

FAMILY: ULOTRICHACEAE

Ulothrix sp.

FAMILY: MICROSPORACEAE

Microspora sp.

FAMILY: COLEOCHAETACEAE

Coleochaete sp.

ORDER: CLADOPHARALES

FAMILY: CLADOPHORACEAE

Rhizoclonium sp.

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[1]The sources for the listing that follows are:

a. J.T. Moenig and B. Latatos, Algae Induced Water Quality Changes in the Assiniboine River Below the Shellmouth Reservoir as Related to Fish-kill Potential. Report #28. (Winnipeg: Manitoba Department of Mines, Resources and Environmental Management, 1976).

b. Field Notes of Al Beck, Fisheries Biologist, Water Pollution Control, Environmental Management Division, Manitoba Department of Mines, Resources and Environmental Management.

c. Eva Pip, Laboratory Instructor, Department of Biology, University of Winnipeg. Personal communication.

The taxonomic arrangement was by Tyrrell Mendis, Resource Extension Officer, Parks Branch.

ORDER: CHLOROCOCCACEAE

FAMILY: HYDRODICTYACEAE

Pediastrum sp.

FAMILY: OOCYSTACEAE

Schroederia setigera

PHYLUM: PYRRHOPHYTA

SUB-PHYLUM: DINOPHYCEAE

ORDER: DINOKONTAE

FAMILY: CERATIACEAE

Ceratium hirundinella

PHYLUM: CHRYSOPHYTA

SUB-PHYLUM: CHRYSOPHYCEAE

ORDER: CHRYSOMONADALES

FAMILY: OCHROMONADACEAE

Dinobryon sertularia

SUB-PHYLUM: BACILLARIOPHYCEAE

ORDER: CENTRALES

FAMILY: COSCINODISCACEAE

Melosira sp.
Stephanodiscus niagarae

ORDER: PENNALES

FAMILY: TABELLARIACEAE

Tabellaria sp.

FAMILY: MERIDIONACEAE

Meridion sp.

FAMILY: DIATOMACEAE

Diatoma sp.

FAMILY: FRAGILARIACEAE

Asterionella formosa
Fragilaria sp.
Synedra sp.

FAMILY: ACHNANTHACEAE

Cocconeis placentula var. *lineata*

FAMILY: NAVICULACEAE

Navicula sp.
Pinnularia sp.
Stauroneis sp.

FAMILY: GOMPHONEMATACEAE

Gomphonema sp.

FAMILY: CYMBELLACEAE

Cymbella sp.

FAMILY: NITZSCHIACEAE

Nitzschia sp.

PHYLUM: CYANOPHYTA

SUB-PHYLUM: MYXOPHYCEAE

ORDER: HORMOGONALES

FAMILY: OSCILLATORIACEAE

Oscillatoria sp.

FAMILY: NOSTOCACEAE

Anabaena flos-aquae
Aphanizomenon flos-aquae

RESOURCE BASE: MACROPHYTES[1]

PHYLUM: SPERMATOPHYTA

SUB-PHYLUM: ANGIOSPERMAE

CLASS: MONOCOTYLEDONEAE

FAMILY: SPARGANIACEAE

Sparganium sp.	Bur-reeds

FAMILY: ZOSTERACEAE

Ruppia maritima var. *occidentalis*	Ditch-grass
Potamogeton pectinatus	Sago Pondweed
Potamogeton richardsonii	Richardson's Pondweed

FAMILY: ALISMATACEAE

Sagittaria sp.	Arrowheads

CLASS: DICOTYLEDONEAE

FAMILY: NYMPHAEACEAE

Nuphar variegatum	Yellow Pond-lily

FAMILY: HALORAGACEAE

Myriophyllum exalbescens	*Milfoil*

FAMILY: UMBELLIFERAE

Sium suave	Water-parsnip

FAMILY: LENTIBULARIACEAE

Utricularia vulgaris	Bladderwort

[1]This information obtained from Eva Pip, Laboratory Instructor, Department of Biology, University of Winnipeg.

RESOURCE BASE: MUDFLATS: FLORA

PHYLUM: SPERMATOPHYTA

SUB-PHYLUM: MONOCOTYLEDONEAE

FAMILY: TYPHACEAE

Typha latifolia	Common Cat-tail

FAMILY: GRAMINEAE

Glyceria striata	Foul Manna Grass
Poa pratensis	Kentucky Bluegrass
Alopecurus aequalis	Short-awned Foxtail
Beckmannia syzigachne	Slough Grass

FAMILY: CYPERACEAE

Scirpus sp.	Bulrushes
Carex sp.	Sedges

FAMILY: JUNACEAE

Juncus balticus	Baltic Rush

FAMILY: RANUNCULACEAE

Ranunculus gmelini	Small Yellow Buttercup
Ranunculus cymbalaria	Seaside Buttercup
Ranunculus pensylvanicus	Bristly Buttercup

FAMILY: COMPOSITAE

Senecio integerrimus	Entire-leaved Groundsel

RESOURCE BASE: PRAIRIES: FLORA

PHYLUM: PTERIDOPHYTA

FAMILY: SELAGINELLACEAE

Selaginella densa	Small spikemoss

PHYLUM: SPERMATOPHYTA

SUB-PHYLUM: ANGIOSPERMAE

CLASS: MONOCOTYLEDONEAE

FAMILY: GRAMINEAE

SUBFAMILY: FESTUCOIDEAE

TRIBE: FESTUCEAE

Bromus inermis	Smooth Brome-grass
Festuca scabrella	Rough Fescue
Poa compressa	Canada Bluegrass
Poa pratensis	Kentucky Bluegrass

TRIBE: HORDEAE

Agropyron dasystachyum	Northern Wheatgrass
Agropyron repens	Couch-grass
Agropyron trachycaulum	Western Wheatgrass

TRIBE: AVENEAE

Koeleria cristata	June Grass

TRIBE: AGROSTIDEAE

Stipa comata	Common Speargrass
Stipa spartea	Porcupine-grass
Stipa viridula	Green Needle Grass
Agrostis scabra	Hairgrass, Ticklegrass

TRIBE: CHLORIDEAE

Bouteloua gracilis	Blue Grama-grass

TRIBE: PHALARIDEAE

Hierochloe odorata	Sweet Grass

FAMILY: LILIACEAE

Allium textile	Prairie Onion
Lilium philadelphicum	Prairie Lily
Zigadenus elegans	Smooth Camass

FAMILY: SISYRINCHIUM

Sisyrinchium montanum	Blue-eyed Grass

CLASS: DICOTYLEDONEAE

FAMILY: SALICACEAE

Populus tremuloides	Trembling Aspen
Populus balsamifera	Balsam Poplar
Salix discolor	Pussy Willow

FAMILY: CARYOPHYLLACEAE

Cerastium arvense	Field Chickweed

FAMILY: RANUNCULACEAE

Anemone cylindrica	Long-fruited Anemone
Anemone multifida	Cut-leaved Anemone
Anemone patens var. *wolfgangiana*	Prairie Crocus
Anemone riparia	Thimbleweed
Thalictrum confine	Western Meadow-rue

FAMILY: CRUCIFERAE

Thlaspi arvense	Stinkweed
Arabis divaricarpa	Purple Rock-cress

FAMILY: SAXIFRAGACEAE

Heuchera richardsonii	Alumroot

FAMILY: ROSACEAE

Rosa arkansana	Prairie Wild Rose
Geum triflorum	Three-flowered Avens
Prunus virginiana	Choke-cherry
Amelanchier alnifolia	Saskatoon

FAMILY: LEGUMINOSAE

Psoralea argophylla	Silver-leaf Psoralea
Psoralea esculenta	Indian Breadroot
Petalostemum purpureum	Purple Prairie-clover
Oxytropis splendens	Showy Locoweed
Astragalus alpinus	Alpine Milk-vetch
Astragalus bisulcatus	Two-grooved Milk-vetch
Astragalus caryocarpus	Buffalo-bean
Glycyrrhiza lepidota	Wild Licorice

FAMILY: LINACEAE	
Linum lewisii	Lewis' Wild Flax
FAMILY: VIOLACEAE	
Viola pedatifida	Crowfoot Violet
FAMILY: ELAEAGNACEAE	
Elaeagnus commutata	Wolf Willow
FAMILY: ONAGRACEAE	
Gaura coccinea	Scarlet Gaura
FAMILY: ERICACEAE	
Arctostaphylos uva-ursi	Bearberry
FAMILY: ASCLEPIADACEAE	
Asclepias ovalifolia	Dwarf Milkweed
FAMILY: POLEMONIACEAE	
Phlox hoodii	Moss-phlox
FAMILY: BORAGINACEAE	
Lithospermum canescens	Hoary Puccoon
Lithospermum angustifolium	Narrow-leaved Puccoon
Lappula echinata	Blue Bur
FAMILY: LABIATAE	
Monarda fistulosa	Wild Bergamot
FAMILY: RUBIACEAE	
Galium boreale	Northern Bedstraw
FAMILY: CAPRIFOLIACEAE	
Symphoricarpos occidentalis	Western Snowberry
FAMILY: COMPOSITAE	
Chrysopsis villosa	Golden Aster
Erigeron asper	Rough Fleabane
Antennaria aprica	Low Everlasting
Antennaria parrifolia	Small-leaved Everlasting
Gaillardia aristata	Great-flowering Gaillardia
Achillea millefolium	Common Yarrow
Artemisia biennis	Wormwood
Artemisia frigida	Pasture Sage
Senecio canus	Silvery Groundsel
Taraxacum officinale	Dandelion

RESOURCE BASE: WOODS: FLORA

PHYLUM: PTERIDOPHYTA

FAMILY: EQUISETACEAE

Equisetum arvense	Common Horse-tail

FAMILY: OPHIOGLOSSACEAE

Botrychium virginianum	Virginia Grape-fern

FAMILY: POLYPODIACEAE

Matteuccia struthiopteris var. *pensylvanica*	Ostrich Fern
Dryopteris cristata	Crested Shield Fern

FAMILY: LILIACEAE

Disporum trachycarpum	Fairy Bells
Maianthemum canadense	Wild Lily-of-the-valley
Smilacina stellata	False Solomon's Seal

PHYLUM: SPERMATOPHYTA

SUB-PHYLUM: ANGIOSPERMAE

CLASS: DICOTYLEDONEAE

FAMILY: SALICACEAE

Populus tremuloides	Trembling Aspen
Populus balsamifera	Balsam Poplar
Populus deltoides	Cottonwood
Salix interior	Sandbar Willow
Salix pseudomonticola	False Mountain Willow

FAMILY: BETULACEAE

Corylus cornuta	Beaked Hazelnut
Betula papyrifera	Paper Birch

FAMILY: FAGACEAE

Quercus macrocarpa	Bur Oak

FAMILY: URTICACEAE

Urtica dioica	Stinging Nettle

FAMILY: CARYOPHYLLACEAE	
Arenaria lateriflora	Blunt-leaved Sandwort
FAMILY: RANUNCULACEAE	
Caltha palustris	Marsh-marigold
Anemone canadensis	Canada Anemone
Thalictrum polygamum	Tall Meadow-rue
FAMILY: SAXIFRAGACEAE	
Mitella nuda	Bishop's Cap
Ribes Hudsonianum	Northern Black Currant
FAMILY: ROSACEAE	
Rosa sp.	Roses
Fragaria virginiana	Smooth Wild Strawberry
Rubus idaeus	Wild Raspberry
Prunus virginiana	Red-fruited Choke-cherry
Amelanchier alnifolia	Saskatoon
FAMILY: LEGUMINOSAE	
Trifolium sp.	Clover
Lathyrus ochroleucus	Cream-coloured Vetch
FAMILY: ACERACEAE	
Acer negundo	Manitoba Maple
FAMILY: RHAMNACEAE	
Rhamnus alnifolia	Alder-leaved Buckthorn
FAMILY: VIOLACEAE	
Viola renifolia	Kidney-leaved Violet
Viola rugulosa	Western Canada Violet
Viola conspersa	American Dog Violet
FAMILY: ARALIACEAE	
Aralia nudicaulis	Wild Sarsaparilla
FAMILY: CORNACEAE	
Cornus stolonifera	Red-ozier Dogwood
Cornus canadensis	Bunchberry
FAMILY: PYROLACEAE	
Pyrola secunda	One-sided Pyrola
Pyrola asarifolia	Pink Pyrola
FAMILY: HYDROPHYLLACEAE	
Ellisia nyctelea	Waterpod

FAMILY: BORAGINACEAE	
Mertensia paniculata	Lungwort
FAMILY: RUBIACEAE	
Galium triflorum	Three-flowered Bedstraw
Galium boreale	Northern Bedstraw
FAMILY: CAPRIFOLIACEAE	
Sambucus pubens	Red Elderberry
Linnaea borealis	Twinflower
Symphoricarpos albus	Snowberry
Viburnum trilobum	High-bush Cranberry
FAMILY: COMPOSITATE	
Petasites vitifolius	Vine-leaf Petasites

FLORA COLLECTED FROM IMPROVED PASTURE

PHYLUM: SPERMATOPHYTA

SUB-PHYLUM: ANGIOSPERMAE

CLASS: DICOTYLEDONEAE

FAMILY: CRUCIFERAE

Arabis divaricarpa	Purple Rock-cress

FAMILY: LEGUMINOSAE

Lathyrus ochroleucus	Cream-coloured Vetch
Medicago sativa	Alfalfa
Vicia americana	American Vetch

RESOURCE BASE: INVERTEBRATES

PHYLUM: ASCHELMINTHES

CLASS: ROTIFERA

SUBCLASS: MONOGONONTA

ORDER: PLOIMA

FAMILY: BRACHIODIDAE

Keratella sp. — Rotifers

PHYLUM: MOLLUSCA

CLASS: GASTROPODA

SUBCLASS: PULMONATA

ORDER: BASOMMATOPHORA

FAMILY: ANCYLIDAE

Ferrissia sp. — Limpets

FAMILY: PLANORBIIDAE

Gyraulus sp. — Orb Snails

Planorbula sp. — Orb Snails

FAMILY: PHYSIDAE

Physa sp. — Pouch Snails

Aplexa hypnorum

FAMILY: LYMNAEIDAE

Lymnaea stagnalis — Pond Snail

Stagnicola sp.

Stagnicola emarginata

FAMILY: BULIMIDAE

Amnicola

CLASS: PELECYPODA (= BIVALVIA)

ORDER: EULAMELLIBRANCHIA

FAMILY: SPHAERIDAE

Pisidium sp. — Fingernail Clams

PHYLUM: ANNELIDA

CLASS: OLIGOCHAETA

FAMILY: NAIDIDAE

Dero sp.

FAMILY: TUBIFICIDAE

Tubifex sp.

Limnodrilus sp.

Limnodrilus hoffmeister

CLASS: HIRUDINEA

GROUP: RHYNCHOBDELLAE

FAMILY: GLOSSIPHONIIDAE

Helobdella stagnalis — Leech

PHYLUM: ARTHROPODA

CLASS: INSECTA

SUBCLASS: EXOPTERYGOTA

ORDER: EPHEMEROPTERA — Mayflies

ORDER: ODONATA — Dragonflies

SUBCLASS: ENDOPTERYGOTA

ORDER: DIPTERA

SUB-ORDER: NEMATOCERA

FAMILY: CHIRONOMIDAE

Chironomus sp. — Non-biting Midges

Chironomus riparius

Chironomus attenuatus

Tanytarsus sp.

Polypedium sp.
Glyptotendipes sp.
Glyptotendipes senilis
Cryptochironomus
Cryptochironomus abortivus
Paracladopelma nais
Procladius
Crictopus

CLASS: CRUSTACEA

SUBCLASS: BRANCHIOPODA

ORDER: ANOSTRACA — Fairy Shrimps

ORDER: CLADOCERA

FAMILY: DAPHNIIDAE

Daphnia pulex — Water Flea

FAMILY: CHYDORIDAE

Alona sp.

FAMILY: BOSMINIDAE

Bosmina longirostris — Water Flea

SUBCLASS: COPEPODA

ORDER: CALANOIDA

FAMILY: CENTROPAGIDAE

ORDER: CYCLOPOIDA

FAMILY: CYCLOPIDAE — Free-living Cyclopoids

SUBCLASS: OSTRACODA — Seed Shrimps

SUBCLASS: MALACOSTRACA

SUPER ORDER: PERACARIDA

ORDER: AMPHIPODA

SUB-ORDER: GAMMARIDEA

FAMILY: GAMMARIDAE

Gammarous sp. Scuds, Sideswimmers

FAMILY: TALITRIDAE

Hyallela sp.

CLASS: ARACHNIDA

Hydracarina Water Mites

RESOURCE BASE: AMPHIBIANS

PHYLUM: CHORDATA

SUB-PHYLUM: VERTEBRATA

CLASS: AMPHIPIA

ORDER: SALIENTIA

SUB-ORDER: DIPLASIOCOELA

FAMILY: RANIDAE

Rana pipiens	Leopard Frog
Rana sp.	True Frogs

RESOURCE BASE: PISCIFAUNA[1]

PHYLUM: CHORDATA

SUBPHYLUM: VERTEBRATA

CLASS: PISCES

SUBCLASS: NEOPTERYGII

ORDER: ISOSPONDYLI

SUBORDER: CLUPEOIDEA

FAMILY: HIODONTIDAE

Hiodon alosoides	Goldeye
Hiodon tergisus	Mooneye

ORDER: HAPLOMI

FAMILY: ESOCIDAE

Esox lucius	Northern Pike

ORDER: OSTARIOPHYSI

SUBORDER: CYPRINOIDEA

FAMILY: CATASTOMIDAE

Catastomus catastomus	Longnose Sucker
Catastomus commersoni	White Sucker
Ictiobus cyprinellus	Bigmouth Buffalo

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[1] This information has been obtained from

a. Manitoba, Department of Mines and Natural Resources, Shellmouth Designated Reservoir Area: Proposed Land Use Plan, by M.C. May et al. Canada Lands Inventory Project. Report #7. (Winnipeg: ARDA, 1969).

b. W.B. Scott and E.J. Crossman, Freshwater Fishes of Canada. Bulletin 184. (Ottawa: Fisheries Resource Board of Canada, 1973.

FAMILY: CYPRINIDAE

Cyprinus carpio	Carp
Couesius plumbeus	Lake Chub
Hybognathus hankinsoni	Brassy Minnow
Notropis atherinoides	Emerald Shiner
Notropis blennius	River Shiner
Notropis cornutus	Common Shiner
Notropis heterolepis	Blacknose Shiner
Notropis hudsonius	Spottail Shiner
Notropis stramineus	Sand Shiner
Pimephales promelas	Flathead Minnow
Platygobio gracilis	Flathead Chub
Semotilus atromaculatus	Creek Chub
Semotilus margarita	Pearl Dace

SUBORDER: SILUROIDEA

FAMILY: AMEIURIDAE

Ictalarus nebulosus	Brown Bullhead

ORDER: ANACANTHINI

FAMILY: GADIDAE

Lota lota	Burbot

ORDER: PERCOMORPHI

SUBORDER: PERCOIDEA

FAMILY: PERCIDAE

Perca flavoscens	Yellow Perch
Percina maculata	Blackside Darter
Stizostedion canadense	Sauger
Stizostedion vitreum	Walleye (Pickerel)

FAMILY: CENTRARCHIDAE

Ambloplites rupestris	Rock Bass

ORDER: THORACOSTEI

FAMILY: GASTEROSTEIDAE

Culaea inconstans	Brook Stickleback
Pungitius pungitius	Ninespine Stickleback

CHARACTERISTICS OF PISCIFAUNA

TABLE 5

CHARACTERISTICS OF PISCIFAUNA

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
Northern Pike	*Esox lucius*	18"-30"	Dorsal: Dark Green Lateral: Bright Green Misc.: Light Spots	Young: Zooplankton Immature Aquatic Insects Adult: 90%: Trout Perch Bass Walleye 10%: Frogs Crayfish Mice Muskrats Ducklings	Variable	Commercial Sport Fish
Walleye	*Stizostedion vitreum*	13"-20"	Pattern on olive-brown to golden brown background.	Young: Copepods Cladocera Fish Fry Adult: Yellow Perch Minespine Stickleback White Sucker Longnose Sucker	Rocky areas in white water. Below impassable falls and dams. Coarse gravel shoals of lakes.	Commercial Sport Fish

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
				Walleye Spottail Shiner Darters Rock Bass Brown Bullhead Goldeye Mooneye Burbot Minnows Crayfish Snails Frogs Small Mammals		
Sauger	*Stizostedion canadense*	10"-16"	Dark brown markings on sandy to dull brown.	Young: Zooplankton Chironomid Larva Adult: Emerald Shiner Walleye Sauger Yellow Perch Burbot Flathead Chub Sticklebacks Leeches Crayfish Insects	Large shallow lakes which are turbid with colloidal clay suspension and turbid fast-flowing rivers.	Commercial Sport Fish

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
Yellow Perch	*Perca flavescens*	4"-10"	Dorsal: Black Lateral: Yellow Green Misc.: Black Bars From Dorsal Along Sides	Young: Cladocerans Ostracods Chironomid Larvae Adult: Odonata Nymphs Ephemeroptera Molluscs Ostracods Chironomid Larvae Small Fish		Commercial Sport Fish
Goldeye	*Hiodon alosoides*	12"-15"	Dorsal: Dark Blue to Green Lateral: Blue-green Ventral: Silver-white Scales: Golden Lustre	Young: *Daphnia* *Diaphanosoma* *Acroperus* *Bosmina* *Moina* *Diatomus* *Cyclops* Adult: Insects Spottail Shiner Yellow Perch Darters Sticklebacks		

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
Mooneye	*Hiodon tergisus*	10"-12"	Dorsal: Olive-brown Lateral: Silvery Ventral: White Scales: Steel-blue Lustre	Small Fish Molluscs Crayfish Plankton Insects: Mayfly Larvae Snipe Flies Chironomid Larvae Mosquito Larvae Damselflies Dragonfly Larvae	Variable with age found mostly in non-flowing water.	Some Commercial
Rock Bass	*Ambloplites rupestris*	6"-10"	Dorsal: Olive-brown Lateral: Brown to Olive Ventral: Silvery White Misc.: Vague Saddle Marks, Bars or Blotches	Chironomid Larvae Ephemeroptera Odonata Cladocera Amphipoda Isopoda Copepoda Hydracarina Trichoptera Crayfish Minnows Yellow Perch Rock Bass Fry Anisoptera	Rocky areas in shallow lakes.	Ecological Association with other species.
Brown Bullhead	*Ictalurus nebulosus*	8"-14"	Dorsal: Yellow-brown Lateral: Grey to Blue-black Ventral: Yellow-white Misc.: Mottled With Vague Brown Blotches	Young: Chironomid Larvae Cladocerans Ostracods Amphipods Mayflies Hemipterans Fish Fry and Eggs	Near or on bottom in shallow warm waters of lakes	Some Commercial Some Recreational Scavenger niche in energy transfer series.

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
				Adult: Offal Molluscs Insects Leeches Crustaceans Worms Algae and Plants Fish Fry and Eggs		
Burbot	*Lota lota*	15"	Dorsal: Dark Lateral: Dark Ventral: Dark Misc.: Lacelike Pattern of Dark Brown or Black	Young: *Gammarus* Mayfly Nymphs Crayfish Adult: Aquatic Insects Crayfish Molluscs Walleye Yellow Perch Sticklebacks White Bass	Deep waters of lakes at night and shallower water during summer day. Rocky shores and weedy areas.	Coarse Fish Commercial value in Europe. Ice Fishing Sport Fish
Bigmouth Buffalo	*Ictiobus cyprinellus*	10"-18"	Dorsal: Dull Brown-olive Lateral: Lighter Ventral: White	Young: Cladocerans Copepods Chironomid Larvae Aquatic Beetles Amphipods Nauplii Ostracods Diatoms	Shallow depths in slow, sluggish or still water of large rivers and shallow lakes. Well adapted to reservoirs and tolerant of turbid water.	Some Commercial

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
				Adult: Entomostraca Aquatic Beetles Bugs Molluscs Amphipods		
Longnose Sucker	*Catostomus catostomus*	12"-14"	Dorsal: Grey, Copper Brown to Brown Lateral: Brown-black Ventral: Cream to White	Variable from place to place, season to season, and by size. Mostly invertebrates: Amphipods *Hyalella* Trichoptera Chironomids Ephemeroptera Ostracods Gastropods Coleoptera Pelecypoda Copepods Cladocerans	Cold, clear lake bottoms or tributary streams.	Commercial (Mullet) Used extensively by people of Northern Canada.
White Sucker	*Catostomus commersoni*	12"-20"	Dorsal: Dark Olive Lateral: Brown-black Ventral: Cream to White	Young: Plankton Small Invertebrates Adult: Chironomids Molluscs Cladocerans	Warm shallow lakes or shallow bays. Tributary rivers of larger lakes.	Commercial (Mullet) Bait Fish

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
Carp	*Cyprinus carpio*	15"-18"	Dorsal: Olive-green Lateral: Lighter Ventral: Yellow	Aquatic Insects Crustaceans Annelids Molluscs Plants	Thrive in waters rendered unsuitable (Eutrophication)	Coarse Fish (Increase turbidity of waters and uproot aquatics essential to other species.)
Blackside Darter	*Percina maculata*	2"-3"	Indistinct Dark Saddle-shaped Markings on Straw-coloured to Olive-brown Background.	Mayfly Larvae Chironomids Corixid Nymphs Copepods Fish Fry	Quiet regions and pools of medium size. Gravel bed streams.	Forage Fish
Flathead Chub	*Platygobio gracilis*	5"-7"	Dorsal: Brown Lateral: Silvery Ventral: White	Water Boatmen Ants Beetles Dipterans	Turbid flowing waters. Main channels of large rivers.	Bait Fish Forage Fish
Lake Chub	*Couesius plumbeus*	4"	Dorsal: Olive to Olive-brown Lateral: Silvery with Dark Pigments Ventral: Silver-white	Chironomid Larvae Aquatic Insects Cladocerans Algae	Lakes or large rivers.	Forage Fish
Creek Chub	*Semotilus atromaculatus*	4"	Dorsal: Olive Black Lateral: Silver Ventral: Silver White	Young: Plankton Adult: Aquatic and terrestrial Insects Beetles Mayflies Caddisflies Chironomids Crayfish Fish Fry	Small clear streams. Shores of large lakes.	bait Minnow Forage Fish

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
Pearl Dace	*Semotilus margarita*	3½"	Dorsal: Dark Black Lateral: Silver Ventral: Silver-grey to White	Copepods Cladocerans Chironomids Beetles Filamentous Algae	Cool, clear headwaters of streams. Bog drainage streams. Shores of large lakes.	Bait Minnow Forage Fish
Flathead Minnow	*Pimephales promelas*	2"	Dorsal: Dark to Olive-green Lateral: Silvery or Brassy Ventral: Silvery White	Algae Organic Detritus Aquatic Insects Zooplankton	Variable In the prairies it occurs in reservoirs, muddy brooks and alkaline lakes.	Bait Fish Forage Fish
Common Shiner	*Notropis cornutus*	2¼"-4"	Dorsal: Olive-green With Purple Dorsal Strips Lateral: Silver Ventral: Silver-white Misc.: Overall Silver and Bronze Tints	Aquatic Insects Algae Aquatic Plants Protozoans Fish Fry	Shores of clear water lakes. Streams	Bait Fish (Northern Pike, Walleye) Forage Fish
Emerald Shiner	*Notropis atherinoides*	2"-3"	Dorsal: Green Iridescense Lateral: Silver Ventral: Silver-white Misc.: Dark Lateral Band	Microcrustaceans Chironomids Algae	Pelagic open water species inhabiting lakes or large rivers.	Bait Fish Forage Fish
Spottail Shiner	*Notropis hudsonius*	2½"-3"	Dorsal: Green to Olive Lateral: Silver Ventral: Silver-white	*Hyalella* *Gammarus* *Mysis* *Leptodora* Chironomids Ephemeroptera	Large lakes and rivers.	Bait Fish Forage Fish

TABLE 5 - Continued

Common Name	Scientific Name	Size	Colour	Diet	Habitat	Significance
River Shiner	*Notropia blennius*	2½"-3"	Dorsal: Light Brown Lateral: Strip	?	Shallow areas with sand or gravel bottoms.	Forage Fish
Blacknose Shiner	*Notropia heterolepis*	2¼"	Dorsal: Black Lateral: Dark Band Ventral: Silver-white	Insects Cladocerans Green Algae	Shallow water with sand or gravel bottom. Common in small lakes.	Bait Fish Forage Fish
Sand Shiner	*Notropia stramineus*	2"-3"	Dorsal: Silver Lateral: Silver Ventral: Silver Misc.: Straw coloured Tints Dark Lateral Band	Aquatic and terrestrial insects Bottom Ooze Diatoms	Sandy shallows of lakes and rivers where growth of rooted aquatics is sparse.	Hardy Forage Species
Brassy Minnow	*Hybognathus hankinsoni*	2½"	Dorsal: Olive-green Lateral: Brassy Iridescence Ventral: Creamy-white	Plankton Aquatic Insects	Slow Streams Shallow bays or lakes.	Bait Fish Forage Fish
Ninespine Stickleback	*Pungitius pungitius*	2½"	Dorsal: Pale Green Lateral: Irregularly Arranged Dark Bars Ventral: Silver	Aquatic Insects Small Crustaceans Fish Fry and Eggs	Variable	Forage Fish (Yellow Perch and Burbot)
Brook Stickleback	*Culaea inconstans*	2"	Dorsal: Olive-green to Black Lateral: Numerous Light Spots or Light Wavy Lines	Aquatic Insect Larvae Crustaceans Fish Fry and Eggs Brook Stickleback Gastropods Oligochaetes Algae	Clear, cold, densely vegetated waters of small streams. Swampy margins of beach ponds or lakes.	Bait Fish (Occasionally) Laboratory Studies

RESOURCE BASE: AVIFAUNA

PHYLUM: CHORDATA

SUBPHYLUM: VERTEBRATA

CLASS: AVES

ORDER: PODICIPEDIFORMES

FAMILY: PODICIPEDIDAE

Aechmophorus occidentalis Western Grebe

ORDER: CICONIIFORMES

FAMILY: ARDEIDAE

Ardea herodias Great Blue Heron

ORDER: ANSERIFORMES

FAMILY: ANATIDAE

SUB-FAMILY: ANATINAE

Anas platyrhynchos Mallard

Anas discors Blue-winged Teal

ORDER: FALCONIFORMES

FAMILY: CATHARTIDAE

Cathartes aura Turkey Vulture

FAMILY: ACCIPITRIDAE

SUB-FAMILY: ACCIPITRINAE

Accipiter gentilis Goshawk

Accipiter striatus Sharp-shinned Hawk

SUB-FAMILY: BUTEONINAE	
Buteo jamaicensis	Red-tailed Hawk
Buteo swainsoni	Swainson's Hawk
Buteo lagopus	Rough-legged Hawk
SUB-FAMILY: CIRCINAE	
Circus cyaneus	Marsh Hawk
FAMILY: PANDIONIDAE	
Pandion haliaetus	Osprey
FAMILY: FALCONIDAE	
SUB-FAMILY: FALCONINAE	
Falco sparverius	American Kestrel
ORDER: GALLIFROMES	
FAMILY: TETRAONIDAE	
Pedioecetes phasianellus	Sharp-tailed Grouse
Bonasa umbellus	Ruffed Grouse
ORDER: CHARADRIIFORMES	
FAMILY: CHARADRIIDAE	
Charadrius vociferus	Killdeer
FAMILY: SCOLOPACIDAE	
Bartramia longicauda	Upland Plover
Actitis macularia	Spotted Sandpiper
FAMILY: LARIDAE	
SUB-FAMILY: LARINAE	
Larus argentatus	Herring Gull
Larus philadelphia	Bonaparte's Gull
SUB-FAMILY: STERNINAE	
Hydroprogne caspia	Caspian Tern

ORDER: COLUMBIFORMES

FAMILY: COLUMBIDAE

Zenaidura macroura	Mourning Dove

ORDER: STRIGIFORMES

FAMILY: STRIGIDAE

Bubo virginianus	Great Horned Owl
Asio flammeus	Short-eared Owl

ORDER: CORACIIFORMES

FAMILY: ALCEDINIDAE

Megaceryle alcyon	Belted Kingfisher

ORDER: PICIFORMES

FAMILY: PICIDAE

Colaptes auratus	Yellow-shafted Flicker
Sphyrapicus varius	Yellow-bellied Sapsucker
Dendrocopos pubescens	Downy Woodpecker

ORDER: PASSERIFORMES

SUBORDER: TYRANNI

FAMILY: TYRANNIDAE

Sayornis phoebe	Eastern Phoebe
Tyrannus tyrannus	Eastern Kingbird

SUBORDER: PASSERES = OSCINES

FAMILY: ALAUDIDAE

Eremophila alpestris	Horned Lark

FAMILY: HIRUNDINIDAE

Hirundo rustica	Barn Swallow
Petrochelidon pyrrhonota	Cliff Swallow
Progne subis	Purple Martin
Riparia riparia	Bark Swallow

FAMILY: MIMIDAE	
Dumetella carolinensis	Catbird
FAMILY: MUSICAPIDAE	
SUB-FAMILY: TURDINAE	
Turdus migratorius	Robin
Siala sialis	Eastern Bluebird
FAMILY: PARIDAE	
Parus atricapillus	Black-capped Chickadee
FAMILY: PARULIDAE	
Dendroica petechia	Yellow Warbler
FAMILY: VIREONIDAE	
Vireo olivaceus	Red-eyed Virco
FAMILY: ICTERIDAE	
Sturnella neglecta	Western Meadowlark
Agelaius phoeniceus	Red-winged Blackbird
Icterus galbula	Baltimore Oriole
Molothrus ater	Brown-headed Cowbird
FAMILY: FRINGILLIDAE	
Pheucticus ludovicianus	Rose-breasted Grosbeak
Spinus tristis	American Goldfinch
Spizella passerina	Chipping Sparrow
Hesperiphona vespertina	Evening Grosbeak
Pinicola enucleator	Pine Grosbeak
Acanthis flammea	Common Redpoll
Spizella pallida	Clay-coloured Sparrow
Melospiza melodia	Song Sparrow
Plectrophenax nivalis	Snow Bunting
Pooecetes gramineus	Vesper Sparrow
FAMILY: CORVIDAE	
Corvus brachyrhynchos	Common Crow
Pica pica	American Magpie

RESOURCE BASE: MAMMALS

PHYLUM: CHORDATA

SUB-PHYLUM: VERTEBRATA

CLASS: MAMMALIA

SUB-CLASS: PROTOTHERIA

ORDER: LAGOMORPHA

FAMILY: LEPORIDAE

Lepus americanus	Snowshoe Hare
Lepus townsendi	White-tailed Jack-rabbit

ORDER: RODENTIA

SUBORDER: HYSTRICOMORPHA

SUB-ORDER: SCIUROMORPHA

FAMILY: SCIURIDAE

Tamiasciurus hudsonicus	Red Squirrel
Citellus franklini	Franklin's Ground Squirrel
Marmota monax	Woodchuck
Citellus tridecemlineatus	Thirteen-lined Ground Squirrel
Sciurus carolinensus	Gray Squirrel
Citellus richardsoni	Richardson's Ground Squirrel

FAMILY: CASTORIDAE

Castor canadensis	Beaver

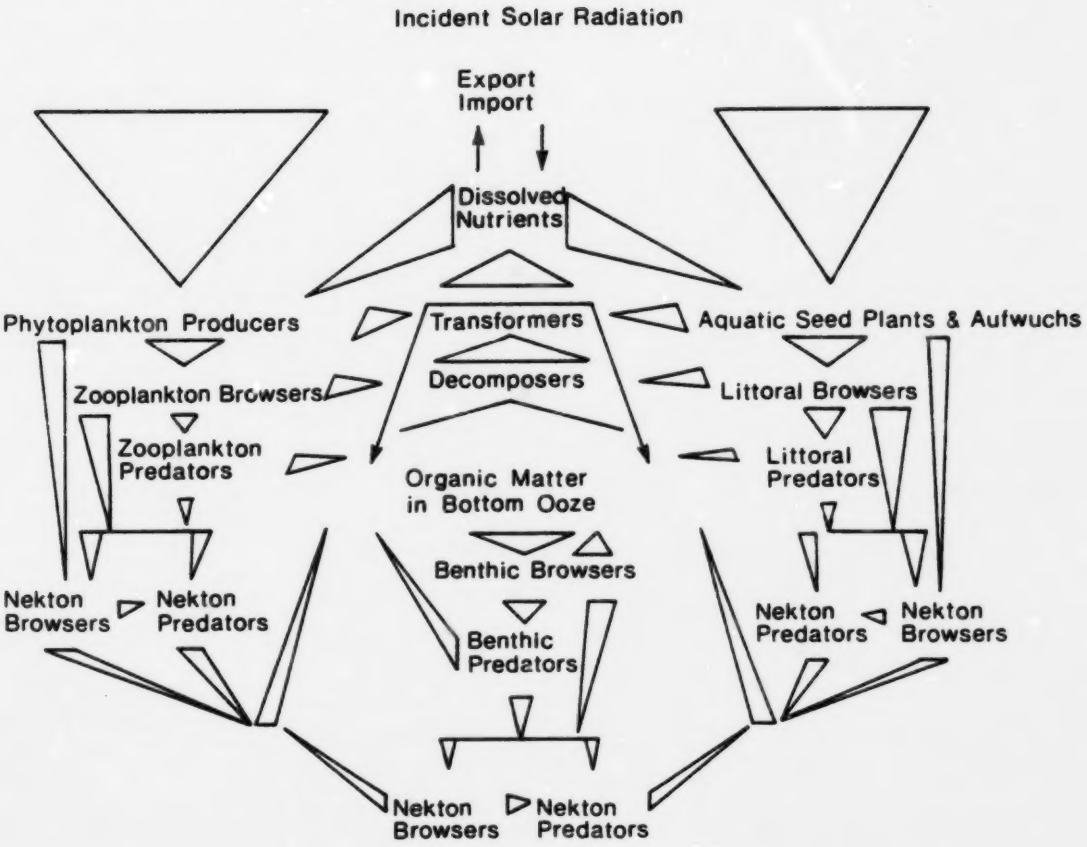
FAMILY: GEOMYIDAE

Thomomys talpides	Northern Pocket Gopher

FAMILY: ERETHIZONTIDAE

Erethizon dorsatum	Porcupine

SUBORDER: MYOMORPHA	
FAMILY: MURIDAE	
SUB-FAMILY: MICROTINAE	
Microtus pennsylvanicus	Meadow Vole
Clethrionomys gapperi	Gapper's Red-backed Vole
SUB-FAMILY: CRICETINAE	
Peromyscus maniculatus	Deer Mouse
Microtus ochrogaster	Prairie Vole
ORDER: CARNIVORA	
SUBORDER: FISSIPEDA	
FAMILY: CANIDAE	
Canis latrans	Coyote
Vulpes fulva regalis	Red Fox
FAMILY: URSIDAE	
Ursus americanus	Black Bear
FAMILY: PROCYONIDAE	
Procyon lotor	Racoon
FAMILY: MUSTELIDAE	
Mephitis mephitis	Striped Skunk
Taxidea taxus	American Badger
Mustela erminea	Ermine/Short-tailed Weasel
ORDER: ARTIODACTYLA	
SUBORDER: RUMINANTIA	
FAMILY: CERVIDAE	
Odocoileus virginianus	White-tailed Deer
Alces americana	Moose

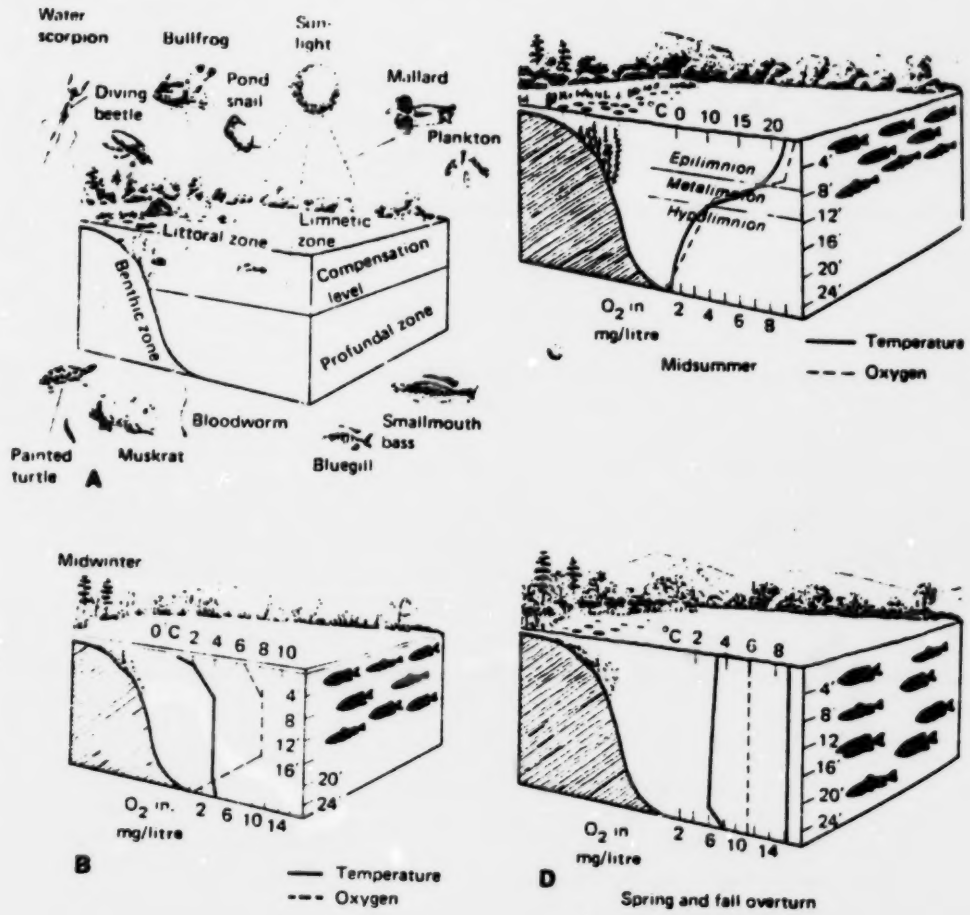


Note: The arrows of various sizes indicate the relative quantities of energy flow.

Source: This diagram was originally designed by Arnold Benson of West Virginia University. Reproduced here from: R.L. Smith, Ecology and Field Biology, 2nd ed., New York: Harper and Row, 1974.

FIGURE 9

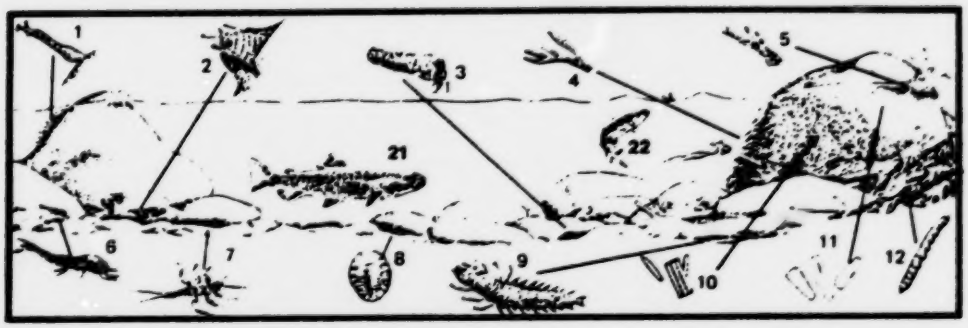
ENERGY TRANSFER



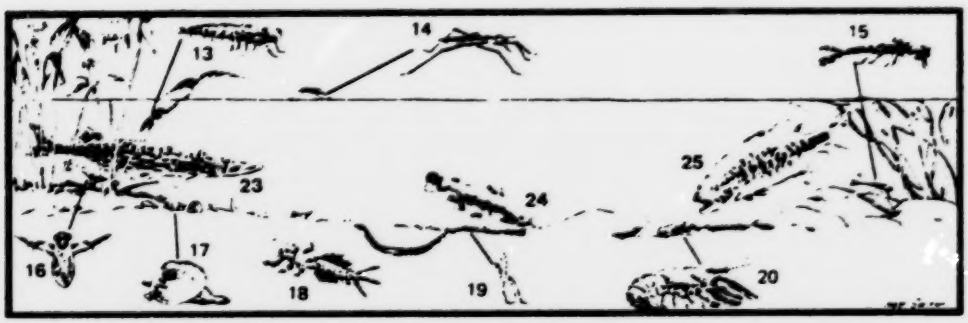
Source: Smith, R.L., Ecology and Field Biology, 2nd Edition, Harper and Row, Publishers, New York, 1974.

FIGURE 10

LOTIC ECOSYSTEM



Fast Stream



Slow Stream

1. Blackfly Larva
2. Net-spinning Caddisfly
3. Stone Case of Caddisfly
4. Water Moss *(Fontinalis)*
5. Alga *(Ulothrix)*
6. Mayfly Nymph *(Isonychia)*
7. Stonefly Nymph *(Perla)*
8. Water Penny
9. Hellgrammite
10. Diatoms *(Diatoma)*
11. Diatoms *(Gomphonema)*
12. Cranefly Larva
13. Dragonfly Nymph
14. Water Strider
15. Damselfly Nymph
16. Water Boatman
17. Fingernail Clam *(Sphaerium)*
18. Burrowing Mayfly Nymph *(Hexagenia)*
19. Bloodworm
20. Crayfish
21. Brook Trout
22. Redbelly Dace
23. Northern Pike
24. Bullhead
25. Small-mouth Bass

FIGURE 11

LIFE IN A FAST STREAM COMPARED TO THAT IN A SLOW STREAM

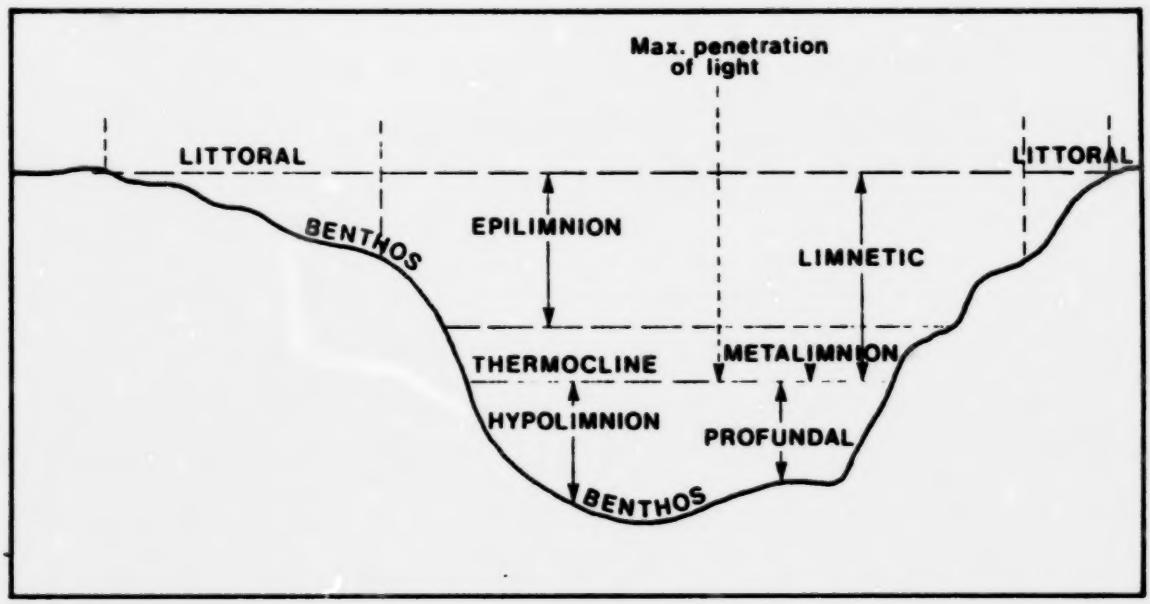


FIGURE 12

LAKE PROFILE

HUMAN IMPACT STUDIES

A. Bison Drives

Bison were essential to the Plains Indians' traditional way of life. Adaptation to the single economy of bison-hunting made a deep impression and is still reflected in the outlook of modern Indians, as shown in their thinking, religion and social activities.[1]

"If one compares the lone hunter or tiny group of hunters stalking a big game animal, with the planned, well co-ordinated effort of the drive it is almost like comparing a cottage industry with a modern factory or abbatoir."[2] Impounding of bison involved the creation of a chute in an upland region, running continuously along a steep grade into a penned area on the valley's floor. The animals, generally incapacitated on their uncontrolled descent along the valley's walls, were easily slaughtered in the pen area.[3] Butchering involved several ritualistic divisions of the kill. Choice sections of meat were first removed leaving most of the meat at the site of the kill. The remainder of the meat was processed for winter use. Large numbers

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[1] T.E. Kehoe, The Gull Lake Site: A Prehistoric Bison Drive in Southwestern Saskatchewan. Publications in Anthropology and History No. 1. (Milwaukee: Milwaukee Public Museum, 1973).

[2] Ibid.

[3] Ibid.

of bison were killed and thoroughly processed, every part of the animal being used.[1] Due to the tremendous accumulation of skeletal material, most of which would not have had immediate use, it can be safely speculated that much remained at the site of the kill.

B. Studies of Human Impact on Reservoir

Currents or continuously moving water is the outstanding feature of streams and rivers. Current cuts the channel, moulds the character of the stream, and influences the life and ways of organisms inhabiting waters. The velocity of flow influences the degree of silt deposition and and the nature of the bottom.

Flowing water also transports nutrients to and carries waste products from many aquatic organisms, and may even sweep them away, balancing this depletion of bottom fauna from areas upstream. Similarly, as nutrients are washed downstream, more are carried in from above. Because of this, the productivity of primary producers in rivers is six to 30 times that of those in standing water.[2] The actions of transport and removal of flowing water benefit such continuous processes as photosynthesis.

The temperature of the stream is not constant. In general, rivers and streams tend to follow but lag behind air temperatures, warming and cooling with the seasons but never falling below freezing in winter.

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[1] Ibid.

[2] R.L. Smith, Ecology and Field Biology. 2nd ed. (New York: Harper & Row, 1974), p. 615.

The constant swirling and churning of river water over ripples and falls result in greater contact with the atmosphere. Thus oxygen content of the water is high at all levels and often is near the saturation point for the existing temperature.

A reservoir differs not only from a stream but also from a natural lake. The differences between reservoir and a stream include[1]

i. depth,
ii. fluctuating water levels,
iii. water detention,
iv. thermal stratification,
v. dissolved oxygen,
vi. inundated soils, and
vii. diverse chemical characteristics.

1. Results of Sampling Along the Assiniboine River Below the Dam

i. Seasonal differences in total residues were not evident. However, increases were evident with descending downstream locations.
ii. Soluble ammonia varied considerably with station and time.
iii. Inorganic carbon varied seasonally, but not from station to station.
iv. Highest values for most nutrients were measured in August, particularly on the fourth of that month.
v. T.K.N. (Total Kjeldhal Nitrogen) values were highest just below the dam, decreasing with downstream stations.

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[1] E. Davies, R.B. Smith and G. Goos, "Predicting Reservoir Water Quality Changes--A Laboratory Investigation". Proceedings, Symposium on the Lakes of Western Canada. (University of Calgary, Water Resources Centre, 1973), pp. 40-55.

2. Chemical Constituents of Reservoir Affecting Density of *Aphanizomenon*.

Levels of phosphorus and nitrogen often exceeded the 0.01 p.p.m. and 0.3 p.p.m. levels, respectively, which are characteristic of eutrophic waters. Reservoir waters also have a relatively high content of sodium, magnesium, chlorine, potassium, calcium, sulphates and bicarbonates.

Lower N/P ratios suggest nitrogen to be a limiting factor; an assumption which would be entirely in accord if *Aphanizomenon flosaquae* is incapable of fixing nitrogen. *Aphanizomenon flosaquae* filaments at stations A1 to H must therefore use available sources of nitrogen as they are released during post-bloom collapse periods.

Phosphorus is not a limiting factor but may be limiting in the reservoir at such times that phosphorus is removed from the water column by the algae during blooming conditions.

Conditions of intense wind may serve at these times not only to precipitate a bloom collapse but also to redistribute nutrient-rich sediments. Increased runoff may also supply additional nutrients triggering off secondary blooms.

3. Limnological Surveys

Because of the fish kill, monthly limnological surveys of the lower 32.8 kilometres of the Shellmouth Reservoir began in December 1972.

Chemical, benthic and plankton data indicate that the reservoir is in an eutrophic state. During the winter five of the seven transects had hypolimnetic oxygen saturation levels of less than 20%.

These low levels of hypolimnetic oxygen have been attributed to the decomposition of organic sediments and the remnants of summer plankton blooms.

Blooms on the reservoir affect the river, with B.O.D. and percentage saturation of oxygen highest on days of high *Aphanizomenon* concentrations. Productivity increases were evident as *Asphanizomenon* pulses progressed downstream. In general, the highest values were at the station closest to the reservoir.

The effect of low oxygen concentrations which cause fish suffocation is probably combined with direct toxic effects of ammonia and other toxic substances, i.e. hydroxylamine, hydrogen sulphide and other unspecified toxic end-products of biodegradation of algal cells.

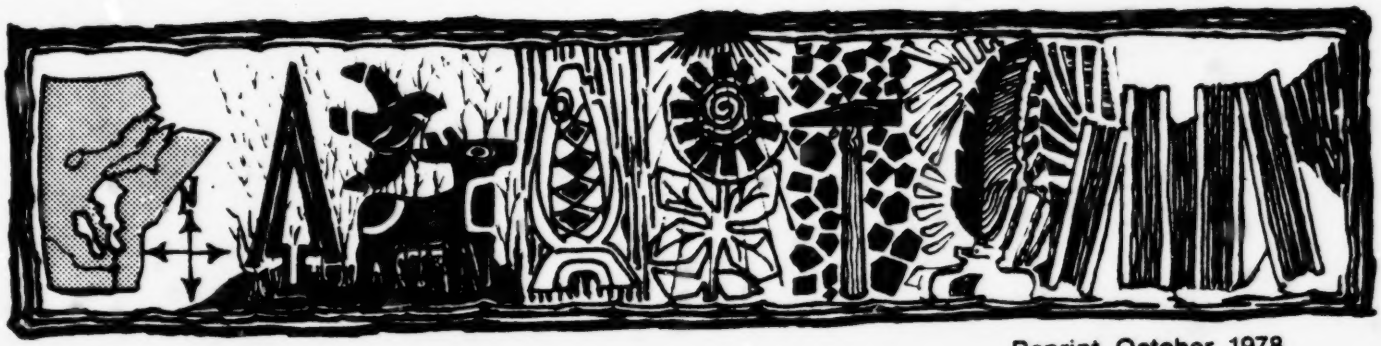
TABLE 6

SPECIES OF DEAD FISH AND OTHER ORGANISMS OBSERVED ALONG THE ASSINIBOINE RIVER FROM SHELLMOUTH DAM TO MILLWOOD DURING THE 1972 FISH-KILL[1]

Species Name	Common Name
Stizostedion vitreum (Mitchill)	Walleye
Stizostedion canadense (Smith)	Sauger
Perca flavescens (Mitchill)	Perch
Ambloplites rupestris (Rafinesque)	Rock Bass
Catostomus commersoni (Lacepede)	White Sucker
Moxostoma aureolum (Le Sueur)	Northern Redhorse Sucker
Cyprinus carpio (Linnaeus)	Carp
Lota lota (Linnaeus)	Burbot
Esox lucius (Linnaeus)	Pike
Ichthyomyzon sp.	Lamprey
	Crayfish
	Clams

[1]J. Barica, "Changes in Water Chemistry Accompanying Summer Fish Kills in Shallow Eutrophic Lakes of Southwestern Manitoba". Proceedings: Symposium on the Lakes of Western Canada. Calgary: (University of Calgary, Water Resources Centre, 1973). pp. 228-242.

conservation comment



Reprint, October, 1978

Extinct, Rare and Endangered Wildlife in Manitoba

". . .when the last individual of a race of living things breathes no more, another heaven and another earth must pass before such a one can be again."

– William Beebe, 1877-1962,
Eminent American naturalist and author

For most of us, the word "extinct" carries a note of dread, a finality, an indignity. Where man has been the cause, especially, society at large remains appalled. The brutal demise of the Great Auk, a large flightless sea bird, incapable of escaping or defending itself, literally clubbed to death – to extinction – for commercial gain, is a particularly jarring example. It formerly bred in Newfoundland and was still in existence as recently as June 3, 1844. Once an organism is extinct, never in all the universe – in all eternity – will that particular species ever occur again. The combination of events that produced a species cannot be duplicated.

The spurious argument raised by a few paleontologists that numerous species have become extinct in the dim past without affecting us (e.g., dinosaurs, which after all, prevailed for thirteen million years!) is no solace. The animals known to modern man have become part of our lives, recorded in prose and poetry, celebrated, part of our memory and we mourn their passing deeply. It is, in fact, the act of mourning for the loss of another species, as pointed out by Aldo Leopold in a dedication address to a monument to the Passenger Pigeon, that distinguishes the human quality.

For Manitoba, extinct species are few – the Passenger Pigeon and perhaps the Eskimo Curlew. Buffalo or bison, though no longer wandering free in the province, still exist in parks and zoos. Kit fox, pronghorn, grizzly bear, muskox, Trumpeter Swan and Greater Prairie Chicken, although absent from our present wild fauna, are still alive and doing fairly well elsewhere. Such species are locally extinct in the province or **extirpated**, to use a more appropriate term. Occasional records of Greater Prairie Chicken in southernmost Manitoba indicate emigration from populations thriving south of the International Border. There seems little likelihood of this species re-establishing itself here, however, owing to almost complete absence of suitable habitat.

Whooping Cranes

Hawk Owl

Rare species are less easily defined. Whooping Cranes are certainly rare, at last count only about seventy-five occurring in the wild. Now and then, Whooping Cranes are seen in Manitoba – an exciting sight – but so far as is known, the species occurs here only as an occasional rare visitor. Once, however, Whooping Cranes nested in Manitoba. Efforts by Canadian and United States wildlife agencies to increase this species, which has hovered on the brink of extinction for decades, are being followed with great interest by a large concerned audience. The first phase of the program has been underway for a decade. Eggs taken from nests at Wood Buffalo National Park have been hatched in incubators in an attempt to form a captive breeding flock. (From two eggs laid, usually only one young survives, so removing one egg is now an accepted practice.) This is a long-range project designed to produce birds to replenish the wild population. In the second phase, which some think may be more successful, Whooping Crane eggs from Wood Buffalo are being slipped into Sandhill Crane nests in Idaho. Seven Whooping Crane chicks have already been successfully reared

by these foster parents. This program is expected to initiate populations of Whooping Cranes in new areas. Consideration is being given by the Canadian Wildlife Service to applying this program in Manitoba's northern Interlake region.

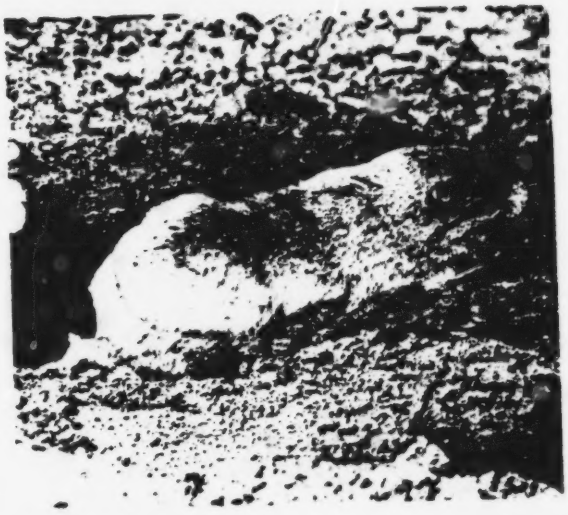
Some rare birds are reported almost annually in the province, but the Black-necked Stilt, White-faced Ibis, or Snowy Egret that is sighted here is rare only in the sense that it is far from its usual range. Of more concern are the species which normally occur here, but which for various reasons, chiefly alteration and reduction of habitat, have declined in recent years. Burrowing Owl, Long-billed Curlew, Ferruginous Hawk and Greater Sandhill Crane fit this category.

Several other wildlife species may be considered rare owing to normal limitations of range or habitat. Some examples of these extra-limital species are: gray fox, fox squirrel, northern pocket gopher, eastern tiger salamander (a subspecies), green frog, plains spadefoot toad, northern prairie skink and plains hognose snake. The latter two reptiles, incidentally, are protected under The Wildlife Act. For many years, literally tons of garter snakes and leopard frogs have been collected in Manitoba for commercial purposes. Their populations are being studied to ensure against over-harvesting.

Mule deer are now rare in the province, but before the advent of white-tailed deer they were fairly abundant, especially in southwestern Manitoba. Changes in habitat, unregulated hunting and other factors seem to have been responsible for the rapid decline of this member of the provincial fauna. Golden Eagles, known to nest in a few far northern localities, may be considered rare breeding residents, but there is no known way of increasing their numbers. All that can be done is to protect nest sites and hope that migrants will stay out of range of ignorant gunners. The wolverine, a relatively lone traveller in the more remote parts of northwestern Manitoba, needs to be studied and may require additional protection as its numbers are uncertain and may have dwindled in recent years. It is not an easy animal to monitor.

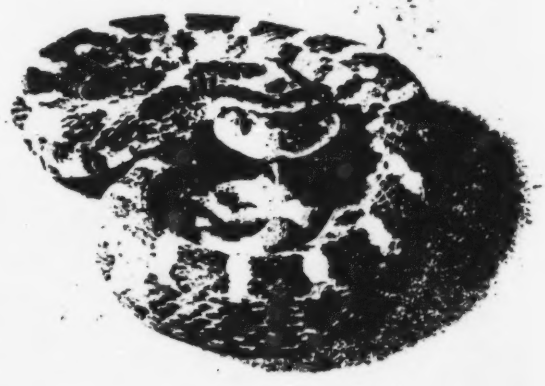
Colonial-nesting, fish-eating birds, especially White Pelicans and Double-crested Cormorants, and several kinds of gulls and terns, are endangered for two major reasons — direct human interference and biocides. Because of their island-nesting habits, which protect them from ground predators such as red fox, striped skunk and coyotes, these birds are highly vulnerable to man. In the past, Manitoba wildlife authorities carried out a campaign to destroy pelican and cormorant eggs, hoping to reduce populations of these birds to support demands by

Burrowing Owl



Northern Pocket Gopher

Hog-Nosed Snake



commercial fishermen. However, when it was discovered that these birds fed almost entirely on coarse fish, this practice was stopped and all birds of this type are now protected. Human visitors to breeding colonies are still a threat. Whether by layman or scientist, a prolonged visit to a colony can result in high mortality of chicks. Up to fifty percent of the chicks in a gull colony for example, may die as a consequence of exposure to sun and especially of harassment from strange adults when the chicks try to find their way back to their parents' small territory. Accordingly, steps are underway to increase protection to breeding colonies by restricting visits and requiring permits for scientists and others who wish to study such birds.

Biocides, that is, poisonous chemicals turned loose on the world by man, threaten not only pelicans, cormorants, gulls and terns, but also Bald Eagles and Ospreys – in short, fish-eating birds. The decline of the latter two species on the United States eastern seaboard has been a drastic example of the way the system works. Mercury is still an unknown factor in this equation, but there is solid evidence of its occurrence in Manitoba waters and in the food chain supporting the above species. (That mercury affects human beings is also evident and a tragedy, but that is another story.)

The general ban on the use of DDT has meant a new lease on life for several other birds on top of primarily terrestrial food chains. The Peregrine Falcon, almost totally eliminated from eastern North America and Europe and also declining in the western United States and parts of its Canadian range, has shown some improvement since DDT was outlawed. But PCB's, highly toxic and long-lasting compounds introduced into the ecosystem

Bald Eagle

Glaucous Gull

of the world as industrial waste products and other complex chemicals not yet identified, still pose serious threats to the welfare of raptors and many, many other creatures

To offset the deleterious effects of biocides and reduced wild populations, both Canadian and United States wildlife authorities and researchers at universities, have embarked on a monumental program to propagate falcons in captivity. It has been a long uphill struggle, but these efforts are beginning to pay off. Co-operation across the country, between nations, between falconers who long ago developed special techniques for handling captive birds, has brought management of falcons to a new peak. Some ingenious methods have been used to rear wild birds, including closed-circuit TV, so that the behaviour of captives can be monitored

without exposing them to humans. Now, young falcons, un-imprinted on man, barely aware of their human captors, are being released in suitable places in the wild in hopes of re-establishing former populations. In addition, in some areas, nest sites are being provided by energetic young men who hang down on ropes over cliffs to excavate small caves, making niches for falcon eyries, a facility the birds are unable to provide for themselves.

Despite legal protection, birds of prey are still being shot, either in righteous defense of game species, out of idle curiosity, or through ignorance. Moreover, magistrates and others who rule on prosecutions, not knowing the value of the raptorial birds, often levy minor fines. If hawks and owls were as numerous as grouse, perhaps it wouldn't matter so much. Ruffed Crouse populations, for example, are little affected by hunting, though hundreds of thousands are shot annually for sport and food. Grouse are an abundant species with high reproductive rates. Except in years of cyclic lows, one can expect to find them everywhere in suitable habitat. Birds of prey, however, being on top of a food chain, are scarce, have low reproductive rates and some are now rare.

The mountain lion or cougar, considered endangered in the eastern United States and Canada, and long regarded as merely a rare vagrant in Manitoba, is now viewed as a permanent resident of this region. There have been several observations of family groups in recent years, indicating a healthy breeding population. Of rare occurrence in the early historic period, it apparently increased as white-tailed deer extended their range into the province. With expansion of the deer herd, cougars increased, or so it would appear. Now this big cat is seen regularly throughout the southern half of the province, even in the intensively farmed area of the southwest. Here, the wooded river valleys and upland groves of trees that are essential winter habitat for deer also provide a home for the cougar.

On December 25, 1973, a cougar was shot and killed north of Beausejour, only thirty-five miles from Winnipeg. Hopefully, now that the cougar's presence in the province has been firmly established, interested persons will continue to contribute information. We do not need another dead cougar, but it is essential to continue gathering records. On January 7, 1974, the cougar was brought under legal protection in Manitoba. A Regulation under The Wildlife Act now prohibits the hunting or killing of cougars. The Regulation states: "Except under authority of a permit issued

Mule Deer

Cougar

Kit Foxes

Gray (Timber) Wolf

by the Minister, no person shall hunt, kill, take or capture a cougar."

Numerous wildlife species are of unknown status in Manitoba because of lack of information. The Manitoba Museum of Man and Nature has for several years been conducting an intensive survey of mammals, collecting small rodents, mice, voles and shrews in every type of habitat, and assessing the relationship between these creatures and their environment. The Department has similarly carried out small rodent surveys in key areas for several years. Biologists plan to establish an index to populations of these animals, which are a vital food base for the valuable furbearers, as a means of predicting annual fur harvests.

Polar bears, on the other extreme, huge carnivores of the North, are being monitored by an international body. Considered endangered on a world-wide basis, the population in the Hudson Bay region is in no danger. Rather, this local population, expecially in Manitoba, may be expanding beyond the capacity of the range to support it. At Churchill, where bears concentrate at certain times of the year, a great deal of time and effort is spent by the Department trying to keep bears and people apart. Bears which are reluctant to leave the townsite are trapped and transported elsewhere. Each year, several recalcitrant bears which threaten human lives are destroyed.

Making people aware of the needs for protection of wildlife and management of habitat has been part of the Department's program for many years. A variety of publications designed for this purpose are available. (Ask for the current publication list.) A prize-winning booklet on the gray (timber) wolf, for example, has already been distributed by the thousands. Equally popular is a coloured booklet on the polar bear. The latter publication provides detailed and current information on this species. Another booklet presents an appealing case for protection of birds of prey. In addition to the usual legal protection of hawks and owls and other raptors, Departmental policy now requires a permit for anyone wanting to have a hawk, owl or other protected bird mounted even though the bird may have been found dead. And permits are issued only when it can be shown that the mounted specimen will be used for educational purposes.

For landowners interested in increasing wildlife on their land, a guide book is available. Like the other publications mentioned above, it is free of charge. Entitled "Manitoba's Wildlife Heritage, A Guide For Landowners", it tells what to do to improve conditions for everything from deer to chickadees. Whether manipulating habitat or build-

Western Grebe

Great Gray Owl

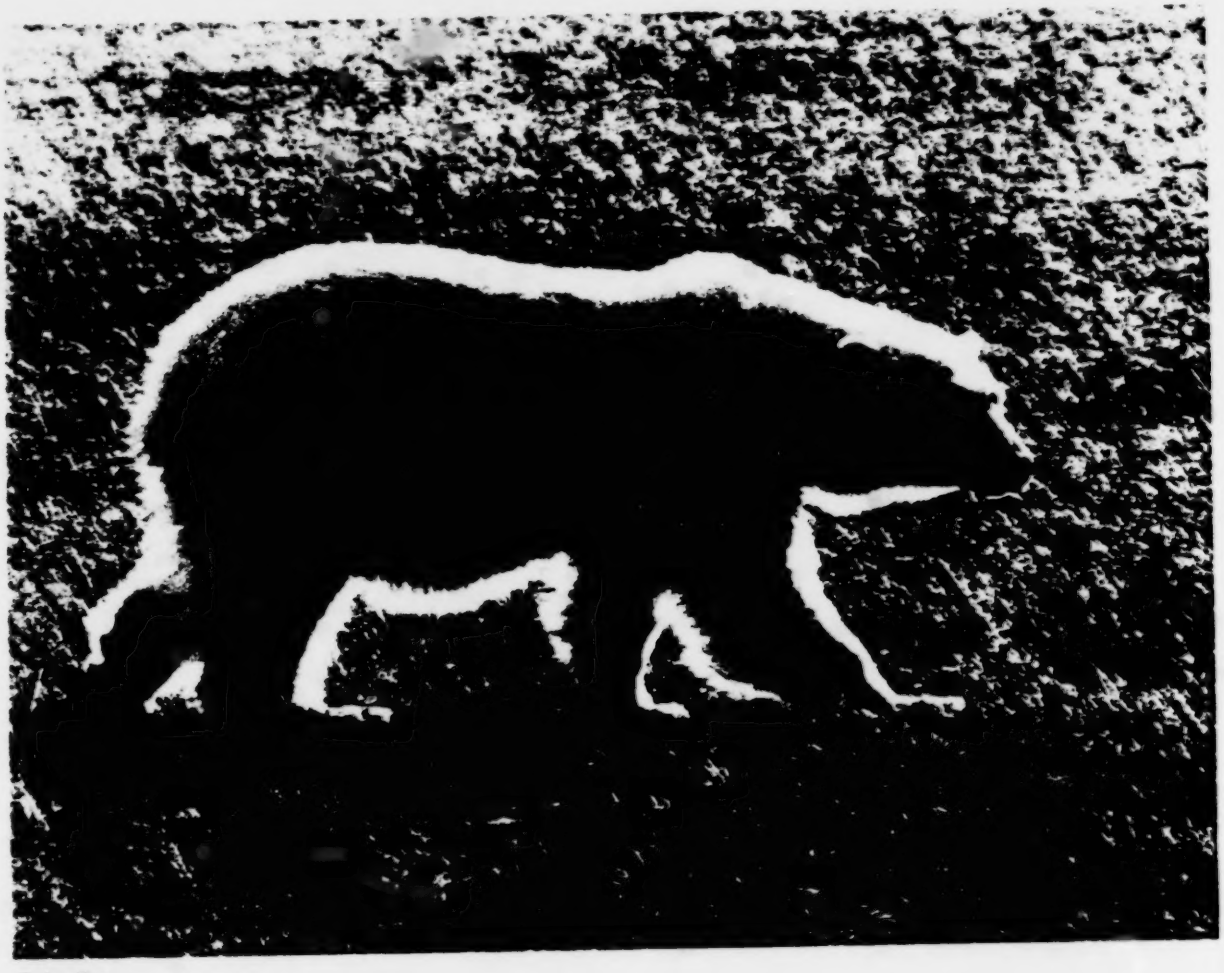
ing a bird feeder, this book offers a lot of information about wildlife needs. The book is appropriately dedicated to "the private landowner . . . in the hope that it will reinforce the wildlife interest and concern he has already shown."

Establishment of wildlife management areas, blocks of land set aside specifically for maintaining and improving habitat for wildlife is a Departmental response to the growing recognition of a need for ensuring permanent sites for wildlife and the increasing number of people who are interested in viewing or hunting game species. Of course, numerous other wildlife animals find a home in such places. In some cases, rare and uncommon species benefit from the protection given to native habitat under the wildlife management area program.

In recent years, the Department in co-operation with the University of Manitoba, has supported a study of the Great Gray Owl, considered by many authorities as one of the rarest of owls. Information on the numbers and distribution of this eagle-sized owl should shed light on its habitat requirements.

The graceful performances made by the beautiful Western Grebe during the breeding season have been shown to many Manitobans through a Departmental film. This colonial-nesting species, which has disappeared in some areas because of human disturbance, has been studied intensively by a graduate student at Delta Marsh. Information on the behaviour and ecology of the Western Grebe, in addition to providing exciting insights into bird communication systems, more than justifies the financial support provided for this project by the Department.

Whether classified as game or non-game wildlife species of Manitoba are subject to numerous pressures. A biocide-free environment – which we all desire because poisons in the ecosystem can affect humans as well – and suitable habitats are basic requirements to ensure the continued presence of existing species and populations of wildlife, whatever their status. The annual harvest of game species is based on fairly secure knowledge of what is available and what numbers can reasonably be taken without jeopardizing local or international



Polar Bear

populations. With all its uncertainties, this system is working pretty well and it is constantly being refined. Hunting, after all, can be controlled.

Ensuring that wildlife species will all find a suitable home in Manitoba is a complex problem. With increased activities in the North, particularly construction of pipelines, roads, landing strips and even settlements, it will be necessary to ensure that the welfare of wildlife species and their habitats is not overlooked. For this reason, impact studies are currently being conducted in several northern areas. Wildlife habitat in general has greatly diminished, especially in agro-Manitoba, through increased agricultural pressure on the land as a consequence of an expanding human population. This is the real threat, and it is to this end that wildlife authorities are directing much of their attention. Rare and endangered wildlife species are receiving considerable attention. This will likely increase as a result of demands by a now well-informed and concerned public. But provision of adequate habitat is essential to maintaining stocks of even common species, as well as a secure and aesthetically pleasing land base.

Robert W. Nero

Photos courtesy of Robert R. Taylor

MANITOBA
DEPARTMENTS OF NORTHERN AFFAIRS
RENEWABLE RESOURCES
AND TRANSPORTATION SERVICES

Hon. Ken MacMaster, Minister

GLOSSARY

ALGAL BLOOM: A sudden increase in the algal population in a water body due to environmental change.

ALLUVIAL DEPOSITS: Deposits of material of any grade which has been carried in suspension by a river or a flood, and laid down where the speed of flow has suffered a check.

ANAEROBIC: Living in the absence of free oxygen.

BED: The smallest division of a stratified series, and marked by a more or less well-defined divisional plane from its neighbours above and below.

BEDROCK: Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

BENTHIC ZONE: The bottom surface and bottom ooze from the water's edge to the greatest depth.

BENTHOS: Organisms such as molluscs and worms inhabiting the benthic zone (q.v.).

CLIMAX: The community (q.v.) of organisms the composition of which is more or less stable, in equilibrium with existing natural environmental conditions.

COMMUNITY: A group of one or more populations of plants and animals in a common spatial arrangement; an ecological unit used in a broad sense to include groups of various sizes and degrees of integration. In a given region, the first community to become established is termed a pioneer community. As conditions change such communities may be followed by intermediate communities which are better adjusted to the newer environmental factors than are the pioneer communities. The intermediate communities are usually followed, by further changes in external factors, by a climax community, the highest type which can be supported by the existing set of external factors and the type which tends to perpetuate itself year after year under similar conditions. This process is called succession (q.v.).

DEPOSITION: 1. The laying down of potential rock-forming material; sedimentation.
2. The precipitation of mineral matter from solution such as the deposition of agate, vein quartz, etc.

END MORAINE: 1. A moraine marking the terminal position of a valley glacier.
2. A terminal moraine (q.v.).

EROSION: The group of processes whereby earthy or rocky material is loosened or dissolved and removed from any part of the earth's surface.

ESKER: A long narrow ridge of gravel and sand deposited by a stream flowing under or within a glacier (q.v.).

EUTROPHIC LAKE: A relatively shallow lake overrich in nutrients either naturally or as the result of artificial pollutants, and hence having a too-abundant growth of water plants and animals.

FLOOD PLAIN: That portion of a river valley, adjacent to the river channel, which is built of sediments during the present regimen of the stream and which is covered with water when the river overflows its banks at flood stages.

FLUVIAL: Pertaining to rivers; growing or living in streams or ponds; produced by river action, as, a fluvial plain.

FORB: A herbaceous plant that is neither a grass nor grass-like such as a sedge, e.g. sunflowers.

GLACIER: A mass of ice with definite lateral limits, with motion in a definite direction, and originating from the compacting of snow by pressure.

GROUND MORAINE: The material deposited from a glacier (q.v.) on the ground surface over which the glacier has moved. It is bordered by lateral moraines (q.v.) and/or end moraines (q.v.).

HABITAT: The sum total of environmental conditions of a special place that is occupied by an organism, a population (q.v.) or a community (q.v.).

LATERAL MORAINE: 1. Certain aggregations of drift which are left by a valley glacier after melting.
2. An elongated body of drift, commonly thin, lying on the surface of a glacier in a valley, at or near the lateral margin of the glacier.
3. An end moraine (q.v.) built along the lateral margin of a glacial lobe occupying a valley. First used by Louis Agassiz.

LAYER: A bed (q.v.) or stratum of rock.

LENTIC: Refers to any body of standing water as in lakes, ponds, etc.

LIMNETIC ZONE: The region of open water, extending from the littoral zone (q.v.) of one shore to the littoral zone of the other shore, and extending downwards to the maximum depth of effective light penetration.

LITTORAL: 1. Belonging to, inhabiting or taking place on or near the shore roughly within a depth to which light and wave action reach.
2. The portion of the benthos (q.v.) which extends approximately 200 metres from the shore.
3. The benthonic environment between the limits of high and low tides.

LITTORAL ZONE: 1. Strictly, the zone bounded by high and low-tide levels.
2. Loosely, the zone related to the shore, extending to some arbitrary shallow depth of water, usually the depth at which plants are rooted. Light reaches the bottom of the water body in this zone.

LOTIC: Refers to any channel of running water as in rivers, streams, etc.

MASS-WASTING: 1. The slow down-slope movement of rock debris.
2. A general term for a variety of processes by which large masses of earth material are moved by gravity either slowly or quickly from one place to another.

MISFIT RIVER: A river whose valley is not in proportion to the size of the river.

MORAINE: A glacial drift ridge deposited chiefly by direct glacial action, its composition being independent of the surface on which it lies.

PHYTOPLANKTON: Plants occurring in plankton (q.v.)

PLANKTON: Floating or weakly-swimming animal or plant organisms occurring at any depth in lakes, ponds, seas or streams.

PLEISTOCENE: The series of sediments deposited during the Pleistocene epoch, including both glacial deposits and ordinary sediments.

POPULATION: 1. A general expression for all concrete plant communities large or small, homogenous or diverse, pure or with mixed composition.
2. The sum total of the individuals of a species in a given area.

RHIZOPOD: A member of the Class Rhizopoda, and includes various species of amoebae. A form of zooplankton (q.v.)

SILT: 1. A classic sediment most of the particles of which are between 1/16 mm. and 1/256 mm.
2. Soil consisting of 80% or more silt and less than 12% clay.

STRATIFICATION: A structure produced by deposition (q.v.) of sediments in beds (q.v.) or layers (q.v.).

SUCCESSION: A series of changes in the life forms of a given region as a result of disturbances in climatic, biotic or topographic factors. Progressive change in composition of a community (q.v.) or organisms towards a largely stable climax (q.v.).

TERMINAL MORAINE: A moraine, formed across the course of a glacier at its farthest advance, at or near a relatively stationary edge or at places marking the termination of important glacial advances. See also END MORAINE.

TERRACE: A level plain usually with abrupt front, bordering a river, lake or sea.

THERMOCLINE: That layer of water situated between the relatively warm surface water and the much colder main mass of water at the bottom. The temperature falls sharply in this layer in contrast to others that are relatively uniform.

TILL: Nonsorted, nonstratified sediment carried or deposited by a glacier (q.v.)

WISCONSIN GLACIATION: Fourth Pleistocene (q.v.) glaciation.

ZOOPLANKTON: Animals occurring in plankton (q.v.).

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POOR

QUALITY

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